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modern plastics

MAY

Surrounded by laminated plastic safety glass the modern traveler is sure that one driving hazard is removed. Continuous research in this field is ever in progress and in May, we will feature an article on the latest developments, along with a complete history of safety glass describing various plastics which have been tried and methods of manufacture. Included also next month will be an article on the method of making unbreakable, ground and polished, all-plastic contact lenses—an important step in optical progress.

APRIL 1941

VOLUME 18 NUMBER 8

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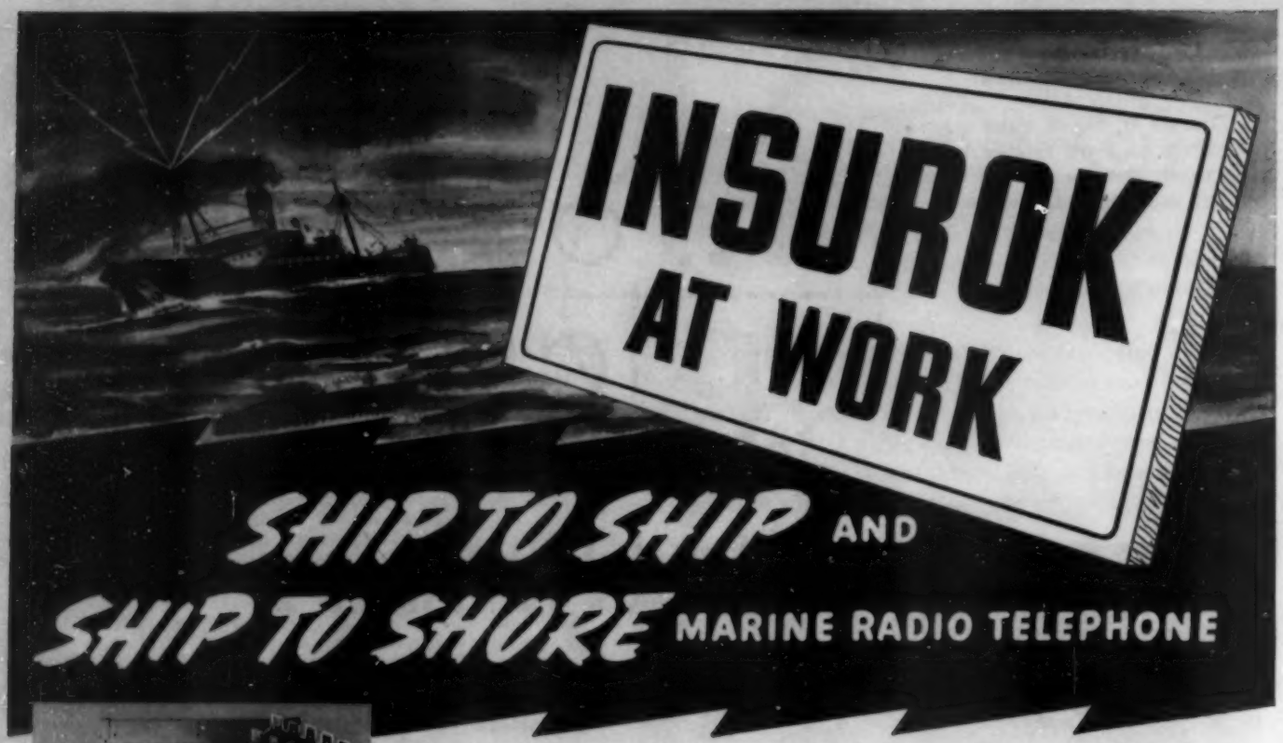

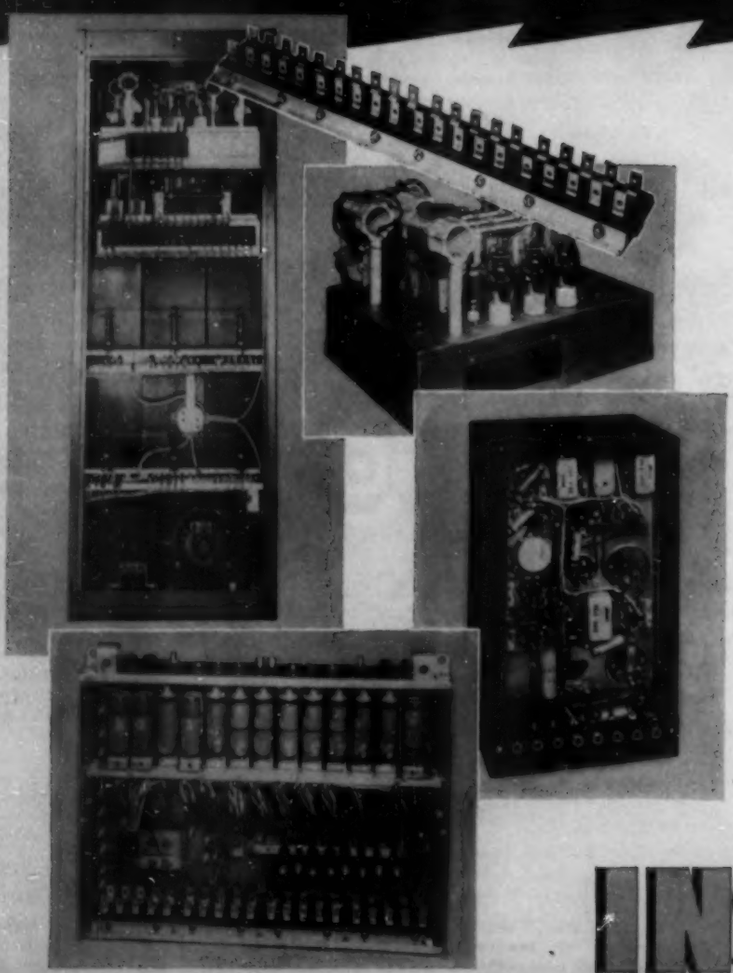

Today's miracle is tomorrow's commonplace. With marine radio telephone scarcely in its teens, its everyday use is taken in the national stride.

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MODERN PLASTICS
WILLIAM T. CRUSE, Editor

APRIL 1941 VOLUME 18 NUMBER 8

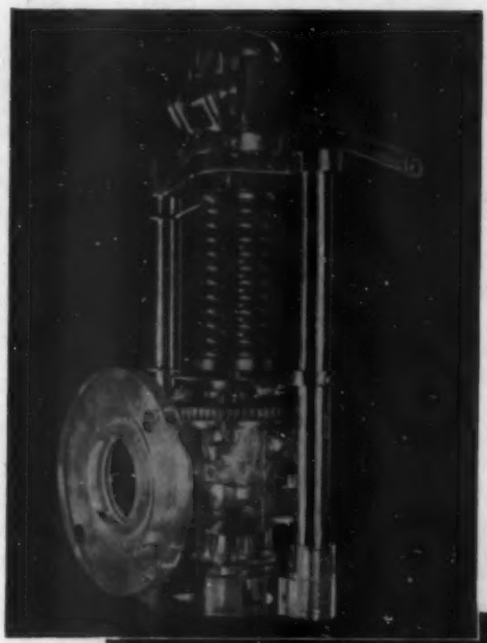
Plastic models

Three-dimensional previews of finished products, plastic pre-production and demonstration models help to promote sales

PLASTIC pre-production models are exact reproductions of the product-to-be. Faithful in detail and in coloring, they are made to scale. As a matter of fact, models are frequently held to such exact dimensions that they serve as a guide to the mold maker.

A plastic model is one of the best insurance policies that a manufacturer can have. Despite the fact that the purchaser, the tool maker and the mold maker can read blueprints, it is much easier to form opinions about a three-dimensional model than it is to visualize what the finished product will look like from some circles, angles and straight lines running helter-skelter on one plane. Moreover, the potential client can see how his article will look and function without the excessive cost of building the actual mold.

Recently a designer told us about his experience in trying to sell a design to a manufacturer. He took the



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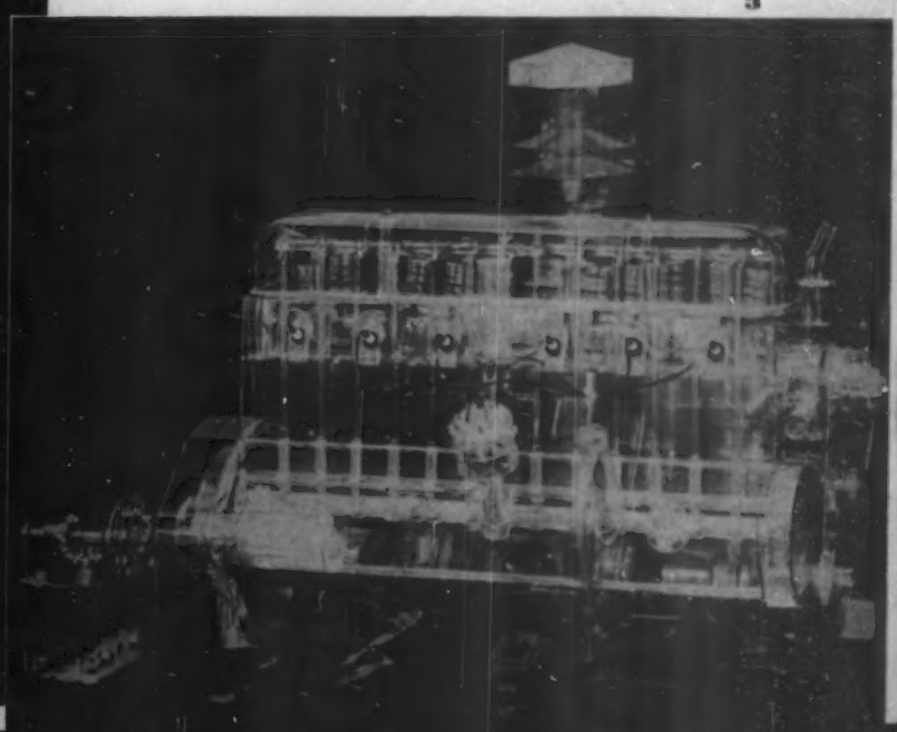

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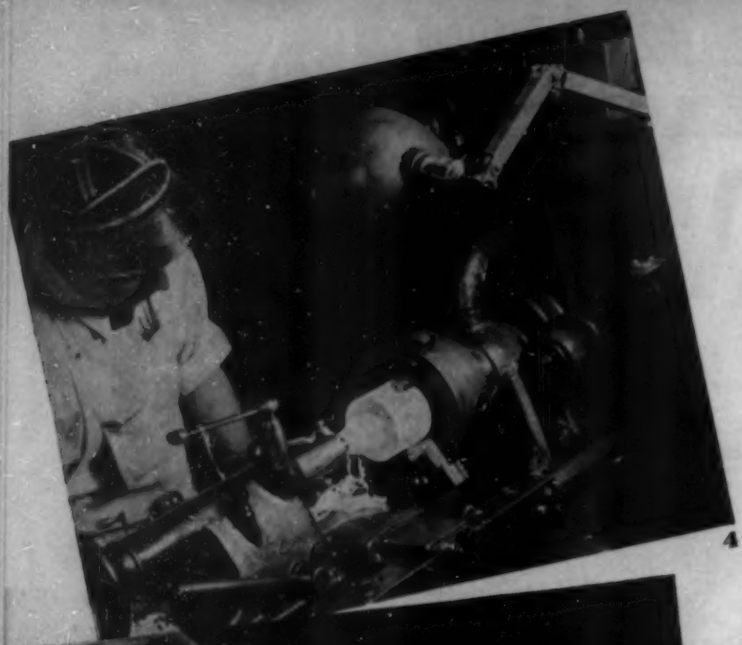
1—Demonstration model of a pressure regulating valve employs transparent acrylic plastic for the mechanism in the base. 2—Methyl methacrylate plus precision work went into this model of a mud pump that really works. 3—Including 1007 intricate individual parts, all of clear cellulose nitrate, this scale model of a 1939 Chevrolet engine is 2/7 actual size



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blueprints, all kinds of sketches and drawings out to the client and after explaining in detail and letting the customer examine everything as long as he wished, he was told to stop work on the design—the customer did not care for it. This designer happens to be a great believer in models, and what's more, he had a hunch that his client would not okay the design merely from the drawings. So he went ahead and had the model made up. Back he went to the manufacturer with the model, and the sale was clinched! Seeing is believing, yes, but seeing plastic models very often results in the saving of considerable time and money.

The cause and effect of a plastic model are far-reaching, indeed. All work including merchandising, market research, even advertising campaigns, and of course the tool and mold makers are dependent upon and stem from the plastic model.

As far as the designer is concerned, a model is the culmination of weeks of intensive study and effort. Previous to the model, everything has to be "visualized." With the model, the visual becomes a live, three-dimensional reality that can be handled by the manufacturer, the advertising and merchandising men, the salesmen. Frequently, the transition is successful, the item acquires new glamor and sales appeal. Sometimes, the result is disappointing, that is, as far as the appearance is concerned. Revisions are found to be necessary, more changes and more work must be done on the plastic model before it looks the way its creator intended it should look. But the purchaser, the designer, the tool and model makers are paradoxically enough, grateful for this disappointment. The cost of the model has already paid for itself many times over; for it is a much simpler job to make revisions on a model than on hard steel molds.

Molders, too, have told us that models made before production not only have saved them actual production headaches but have enabled their customers to "feel out" their markets and even to use the model for actual selling during the period in which the mold was being made.

PHOTOS, COURTESY [illegible]

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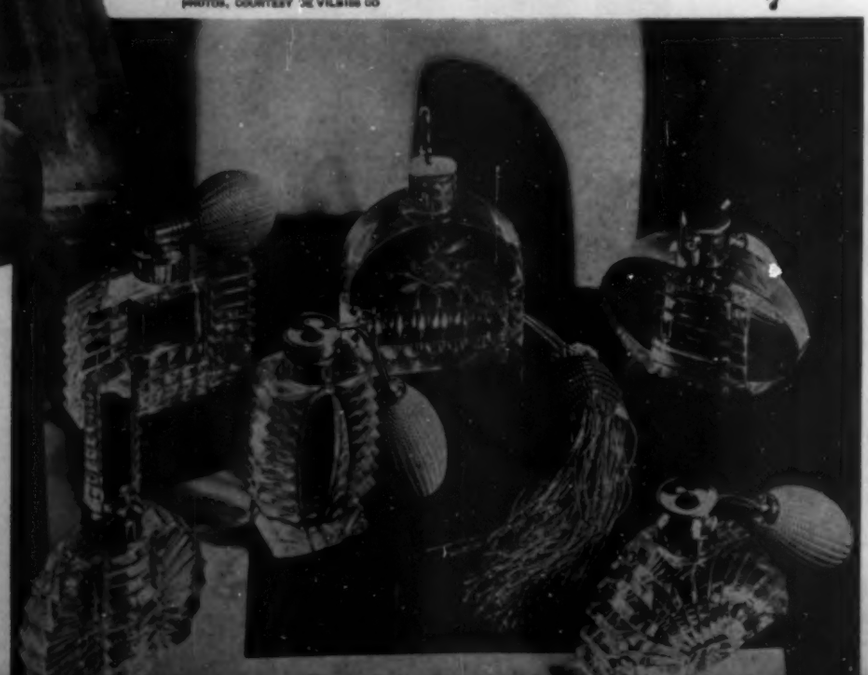
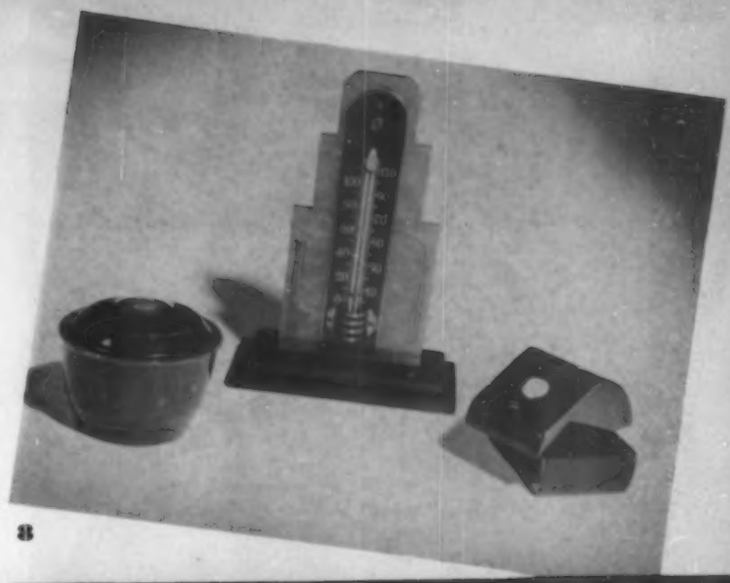


Many a model's corner has been cut, literally, to make for a better molding job. Boxing, shipping weights and specifications can be gaged from the model, so that by the time the molding presses are turning out thousands of articles a day, and the assembly line is providing the manufacturer with mass production quantities of his product, the shipping room boys will be ready for the orders.

For the sales promotion and advertising departments, the plastic model affords the opportunity to "build up" the item, and give it a pre-production push. Comparisons with competitive lines are made possible with the plastic model. How does this two year old item compare in price, beauty and utility with our plastic model? And the answer is there for the conference table executives to see. From high executives down through the sales force to the production department, a plastic model is of inestimable value. According to one prominent designer, "Plastics and a dash of showmanship give the model a custom-tailored appearance and approach the legitimate finished product closer than any other material."

Most model makers try to employ the same type of plastic wherever possible for the model as will ultimately be used in the finished product. The plastic model has the same appearance and contour of the



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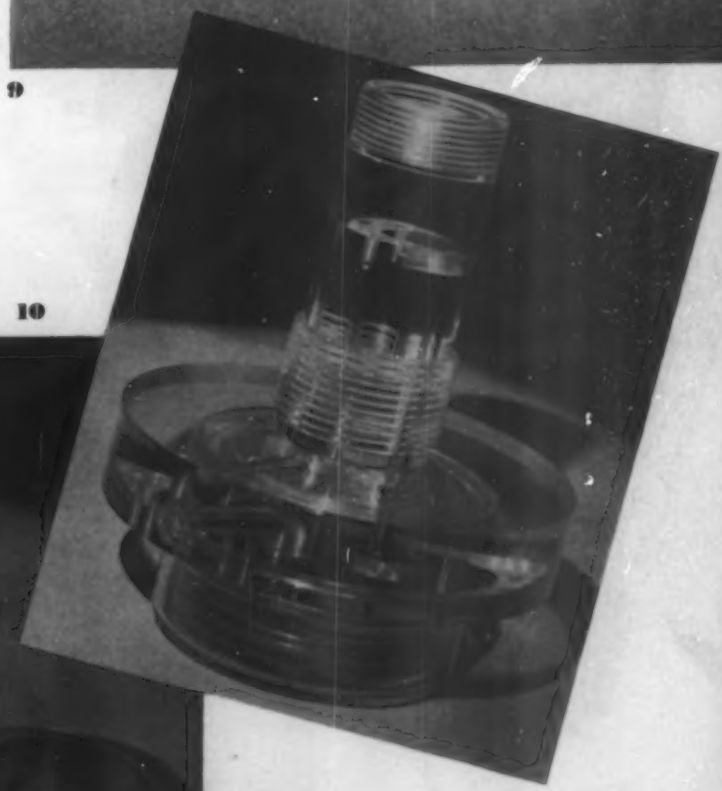

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4—In planning a new line of glass atomizers, this company began with plastic models. From a solid block, the bottle's neck is being turned preliminary to shaping (5). 6—Bottle is then engraved with fine detail so that the result (7) resembles fine crystal. 8—Pre-production models for a small container, a vertical thermometer and a ring box are machined from cast phenolic and blocks of cellulose acetate. 9—Accurate, detailed models (rear) were prepared before molding the decorative cosmetic container in the foreground. 10—A manufacturer of timing mechanisms makes use of methyl methacrylate models (right) in connection with government orders which require precision parts

11

12

13

ultimate article and thus can be subjected to all types of tests, such as mechanical, chemical or thermal, if the finished product is intended to withstand such kind of treatment in action. The plastic model gives the first concrete indication of how the model will stand up structurally under wear.

The plastics generally used for models are: cellulose acetate, methyl methacrylate, cast phenolics and polystyrene, the choice being based on their availability in stock forms and blocks. These materials can be hand-carved with wood-working tools. Revolving cutters of various shapes, sizes and designs make up a large part of the model maker's equipment. The cutter is attacked with the material held in the hand, which means that carving plastics calls for long experience, high artistic skill and the ability to visualize the resulting article from every angle.

Model makers very often have to work from scratch—and that is true both literally and figuratively. The client brings in a very rough sketch of what he wants; the model maker makes a freehand drawing of the article, and upon the customer's approval (in some cases) he makes a rough model in plastics. Upon approval of this, a final model is made and from this the customer's order secured.

Plastics in model making are a time-saving medium with which to work. They cut easily and build up rapidly into the most complex, sharply defined patterns. No longer is it necessary to spray-paint a model with 8 or 10 coats of paint, only to find that the finish is no good and the dimensions of the model are no longer exact. Plastics have eliminated these problems.

One model maker tells us that most of their customers are advertising and production men who know comparatively little about the engineering or technical aspects of a product. Very often the client comes in with a handmade model, that is, one which is made up according to the idea in (*Please turn to page 76*)

11—Only close examination shows that these hangers are handmade models so exact are they. **12**—Cellulose acetate is used for the window and the red and white keys of this cash register model. **13**—A case for a fountain pen and pencil set and two containers for razor heads are machined to the exact dimensions for pre-production models. **14**—Identical twins, the model left, is made of solid cast phenolic, while the dark colored piece is the finished molded inkstand

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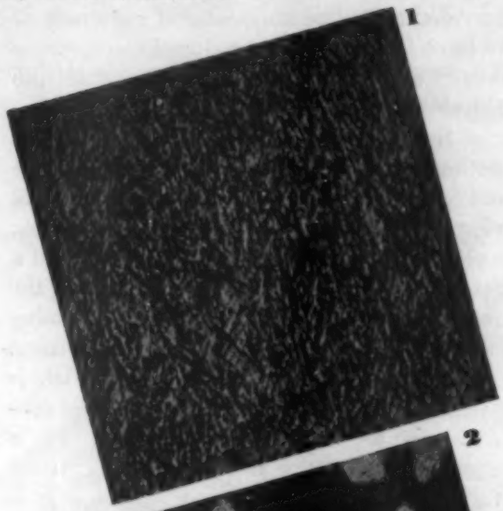
Electroforming molds

By E. H. WALLACE*



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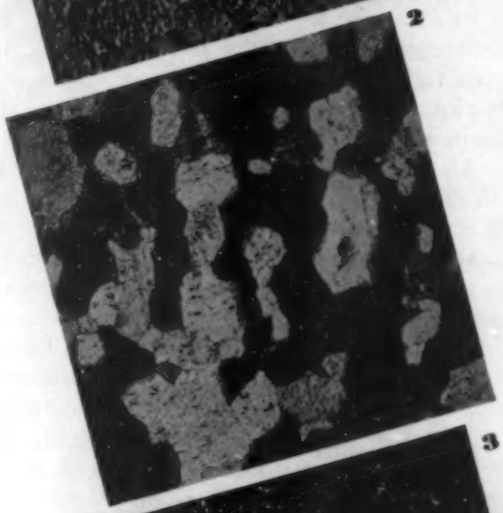

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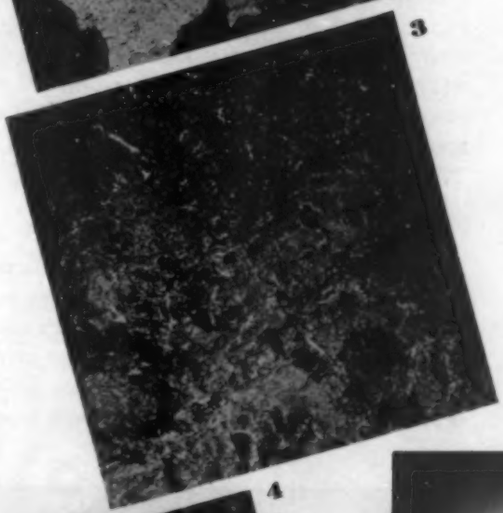

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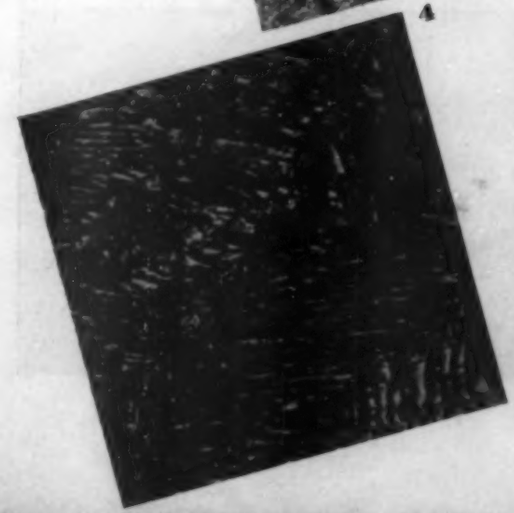

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IN slightly less than two years the plastics industry has become acquainted with the process of electroforming molds and, to a certain degree, has learned the advantages and limitations of cavities electroformed in iron. At the same time the producers of these molds have learned many of the molder's problems.

Such molds are made by depositing iron from an electrolytic bath on a form corresponding to the molded piece. Depending on the particular job a $^1/_8$ in. to $^3/_8$ in. deposit is electroformed which, upon separation, yields a mold cavity reproducing in the finest detail the dimensions, finish, and shape of the pattern. The electroformed shell must be hardened and backed to form a finished mold.

Electroforming is the same as electroplating except that deposits up to $^1/_2$ in. thick are produced instead of the $^1/_{1000}$ in. to $^2/_{1000}$ in. of metal applied by the usual electroplating processes. Electroplating is used for decorative purposes or to provide corrosion resistance while electroforming is used to build up a mass of metal.

The transformation from pure iron deposited in a special crystalline structure to ordinary steel is accomplished through simple annealing and carburizing treatments. Fig. 1 is a photomicrograph of the electroformed iron which has a Brinell hardness of 240. A simple annealing gives the somewhat miraculous change in crystal structure shown in Fig. 2 and a reduction in hardness to Brinell 160. Carburizing for not excessive periods produces steel as in Fig. 3; the typical pearlite structure is shown at higher magnification in Fig. 4. Carbon penetrates from both sides of the electroformed

* Electroforming Dept., U. S. Rubber Co.

Photomicrographs show transformation from pure iron to steel by annealing and carburizing treatments. 1—Iron as electroformed; 2—electroformed iron after annealing; 3—typical case structure of the electroformed steel mold (all magnified by 100). 4—Typical pearlite structure of case steel section (magnified by 1000). 5—Cavity and cavity section showing sprayed iron backing for the electroform

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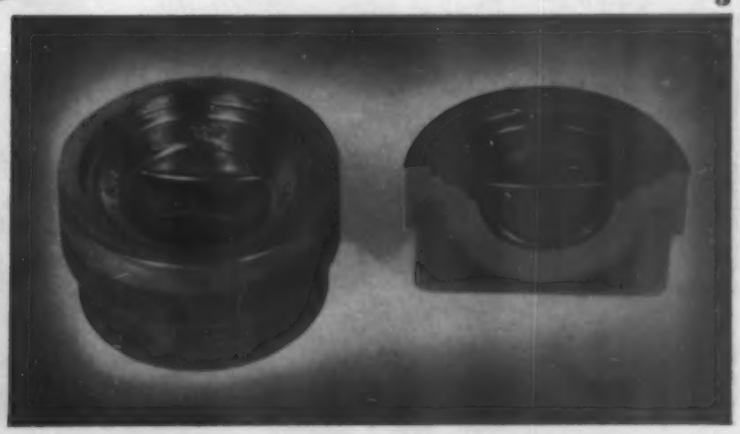

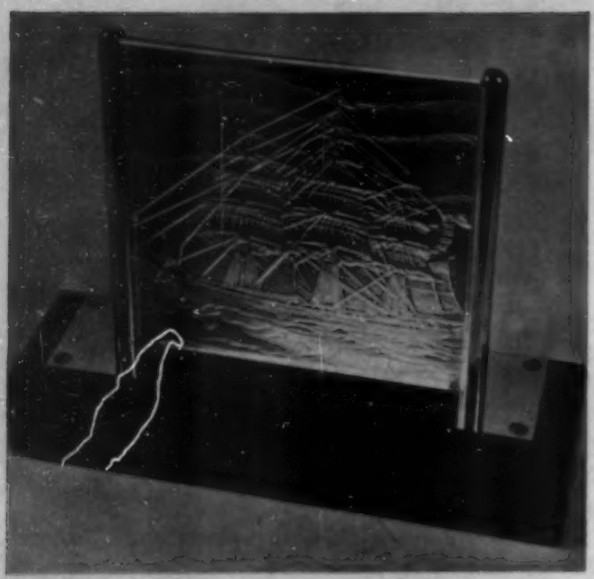

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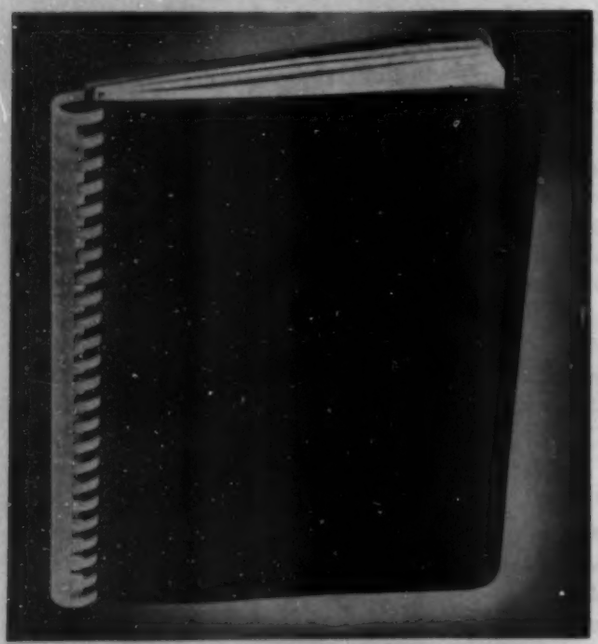

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shell and case depths up to .090 in. are obtained where necessary. Quenching in water or oil yields Rockwell C readings around 63 and a tempering operation is performed when desired. The hardening of hundreds of cavities, we have found, has not produced one instance of prohibitive distortion presumably because the quenching strains are induced in a uniform section.

Backing of the cavity may be accomplished by one of three methods depending on the application. The method used for plastic molds is machining the back of the electroformed cavity for insertion into a steel block. Where the electroformed shell follows the contours of a non-symmetrical or irregular-shaped pattern, fitting the cavity in a steel block may involve more machining than preparation of the complete mold by the usual methods. In these cases a sprayed iron intermediate is applied to the back of the electroform bringing the contours to a shape that is easily machinable. This is demonstrated in Fig. 5 where the line of demarcation between the electroform and the sprayed backing is easily discernible.

The most frequent question asked by the molder is, What kind of pattern is necessary? The answer is: practically anything ranging from a metal, plaster, wood, clay, or glass model to an existing cavity for which duplicates are desired. If the molded piece is to include a shallow ornate design it is only necessary to start with a drawing or photograph which may be transferred to relief in plaster by a special process[1] (see Fig. 6). Many times the degree of finish and dimensional accuracy desired in the cavity cannot be established in plaster, wood, or clay and metal must be used. Brass, steel, or low melting non-shrinking alloys[2] are ideal while zinc, aluminum, or magnesium are ruled out as reactive to the electrolyte. The pattern is preferably arranged with an impression (*Please turn to page 78*)

[1] Ford Ceramic Arts, Inc.
[2] Cerrobase—Cerro De Pasco Copper Corp.

A variety of patterns can be produced by electroforming. 6—A relief plaque of molded methacrylate edgelighted for display. 7—Wood grain design on this book cover is molded in. 8—Leather grain cigaret lighter covers molded of vinyl, cut assembly costs. 9—Highly polished cavities below were electroformed on a watch crystal pattern

9

Nursery suite

Brightly colored extruded and laminated plastics are used in attractive, sanitary, durable furniture

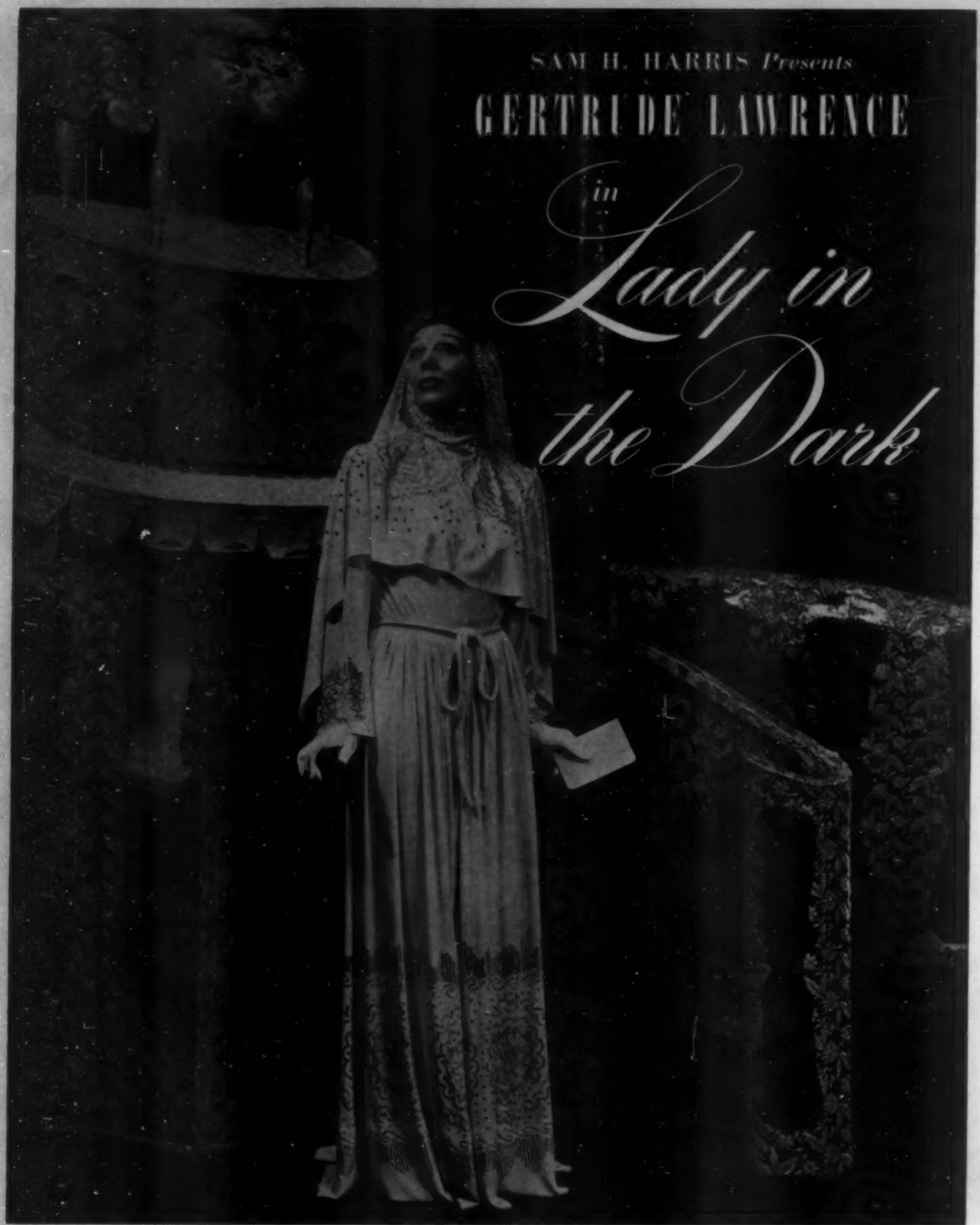
PHOTOS, COURTESY TENNESSEE EASTMAN CORP.

BUYING furniture for the baby's nursery can be very exciting especially when you find charm, simplicity and efficiency combined with the durable loveliness of plastics. This group of nursery furniture custom designed for a private individual is unique, not only because of its use of various types of plastics, but in its new practical, harmonious design.

Sky-blue and a pale salmon color form the background for bleached walnut and woven strands of sparkling, transparent cellulose acetate butyrate. Reminiscent somewhat of a tumbling barrel the bassinet is of an unusual design hanging as it does between two large round rings of bleached walnut, which are covered with sky-blue leatherette. To ward off infection from doting relatives and drafts, two shields of transparent plastic sheets held in walnut frames fit into grooves in the rings and can be slid up to cover the bassinet entirely, or to protect one side, as desired. This idea of the shields is a practical one and was patterned after the hospital custom of permitting visitors to view new-born babes through glass partitions. When the protecting shields are let down, they rest beneath the crib. The bassinet itself is made of interlaced strands of extruded cellulose acetate butyrate and is washable, durable and lovely looking.

Handy little chests for clothing, towels and other necessities can be arranged for convenience. The tops of the chests are surfaced with laminated plastic in the pale salmon tint and linen-like finish. Impervious to scratches, alcohol, medicines, and acids, this type of material is ideal for use in a nursery where haste is often a necessity, but a costly one. Doors are a combination of a woven plastic panel set in a frame covered with blue leatherette. The doors of the cabinets are made up of panels of the extruded plastic that match the body of the bassinet. These panels are set in frames covered with blue leatherette. A soft blue linoleum with a salmon colored border protects the floor. The walls are painted a pale blue. A unity of design, material and color is achieved throughout.

Credits: Materials: Tenite II, Formica, Monsanto cellulose acetate sheet. Designed by Paul Bry.



Lightweight, durable and practically flameproof, plastic scenery creates unusual dramatic effects. Gertrude Lawrence stands in front of a 14 ft. high wedding cake in the fantasy marriage scene of her current play. The cake is built in tiers and is composed of specially treated cellulose acetate, applied over an initial covering of lace. The effect is frosty and sparkling under the powerful stage lights

ON the trail of some 2500 sq. ft. of plastic stage scenery, your cub reporter stood for over three hours to bring you this story on the new Gertrude Lawrence show, *Lady in the Dark*. Not that one should complain with S.R.O. (Standing Room Only) because there were many others, thrilled that they could get in the Alvin Theater to see "Gertie strut her stuff." If you have read the critics' reviews, then you realize that the show is recognized as a success. You also know that the story is concerned with Liza Elliott (Miss Lawrence) as the editor of *Allure*, a fashion magazine. It seems that Miss Elliott has worked herself into a state and feels the need of a little psychoanalysis, and so the scenes shift from the office of the doctor to the editor's office with a generous interspersion of "dream" scenes. There is much music, singing and dancing and, at times, the show goes along at quite a gay pace. But you go to see the show—we'll tell you something about the stage sets, since they embody an extensive and somewhat unusual use of plastics.

The entire stage setting was designed by Harry Horner, student of Reinhardt, and well known for his work in this field. Cellulose acetate in sheets varying from 4 by 18 ft. to 7 by 22 ft. processed by a special technique is found in an abundance throughout. Methyl methacrylate props used in various scenes will immediately catch the eye of any plastic-minded member in the audience.

The first scene shows Dr. Brooks' office and here we find the plastics in the large window through which the sun is supposedly shining. This window is made of translucent urea-laminate and is illuminated from the rear to give the desired effect. Dream, number 1, stems from this visit to the doctor and then we get our first glimpse of the variety of uses to which the specially processed cellulose acetate has been put.

Circular, revolving stages turn upon a darkened set and we find ourselves (*Please turn to page 90*)

Cellulose acetate-treated blue screens, 20 ft. high, form an ethereal background for all of dream scene settings. Above: illuminated postage stamp and artist's palette are plastic, too. Dressing table, at left, is treated similarly, while transparent cellulose acetate sheet stock is used for oversize letters and messages. Note the large methyl methacrylate key

Book and magazine rack

Arranged in a trim specially designed molded phenolic rack, a home study course on the theory and practice of flying is so conveniently assembled for use and ready reference, that even the most procrastinating student is inspired to keep at work. This attractive desk unit of lustrous walnut mottled with gold leaf design holds nine bound volumes of "Aeronautics," aviation lectures, and has a separate compartment for work sheets or maps. An ingenious molding job, the rack consists of ten dividers, molded integrally with the base and ends. Despite the thinness of the spacing ribs, it was essential that they be strong and tough to support the books and withstand constant handling and shipping—thus demanding extra high impact resistance and flexural strength from the plastic used. Overall dimensions of the unit are $15\frac{1}{4}$ in. long by 8 in. deep by $4\frac{1}{2}$ in. at the tallest point. Spacers are $\frac{1}{8}$ in. thick and separated by $1\frac{1}{4}$ in. space. Raised numerals are molded on the front of the rack. Planned as a premium to subscribers, as a "cash-up" and promotion piece, the racks proved so successful that the company reports it is extending the use of the rack to other titles.

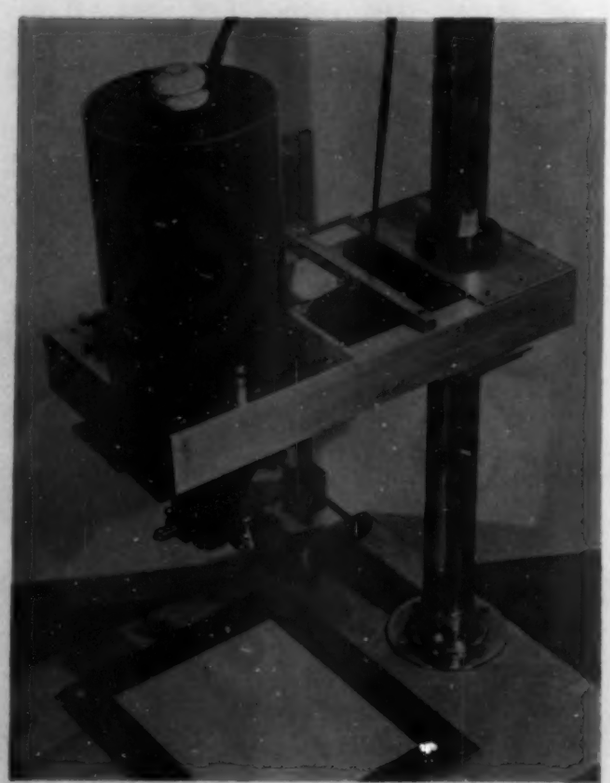
Credits: Resinox, molded by Waterbury Button Co. for National Aeronautics Council, Incorporated.

PRODUCT DEVELOPMENT

Photographic enlarger

Built at home by an amateur photographer, an ingenious precision type enlarger for projection printing, employs plastics in many parts where they have been found to serve better than wood. Strong, lightweight, resistant to chemicals, and easily fabricated with ordinary hand tools, the unit is inexpensive and quiet in operation. The plastic applications include: slide bearings (2 rings cut from $\frac{1}{8}$-in. sheet phenolic) which form the only point of contact between enlarger head and the upright support; lamp housing, 6 in. dia. with $\frac{1}{8}$-in. wall of phenolic laminated, seamless tubing. The top of the light housing is of $\frac{1}{8}$-in. sheet stock, and inside is an arrangement of drilled ventilating holes properly spaced to prevent leakage of light, constructed of $\frac{1}{16}$-in. laminate. The dismantling arrangement for the lamp house consists of 4 blocks of $\frac{1}{2}$-in. phenolic drilled and tapped. In the glass compartment a panel of $\frac{1}{8}$-in. sheet stock gives access to the space where flash opal and heat-proof glass are installed. A hinged plastic holder minimizes the dust problem for the negative carrier. A red filter holder supports a non-warping lens board of $\frac{1}{8}$-in. black phenolic. A dyed gelatine filter is protected by 2 sheets of clear acetate.

Credits: Bakelite phenolic, acetate; made by Robert P. Murray.

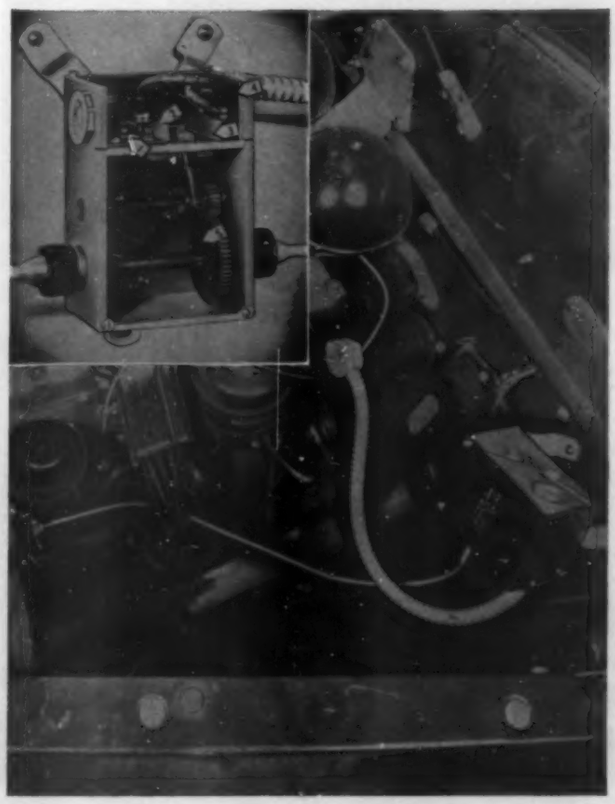


Lather dispenser

Next, please! No waiting while the compact and attractive Sani-Soap unit delivers warm lather to the barber at the push of a release. Of an intricate design, the main housing is of phenolic with assembly bosses, studs and guides molded integrally in the unit, as shown in the lower photograph. This eliminates considerable expense for jigs and fixtures and machining time, and yet exact dimensions and close tolerances are held in the molded piece. The plastic parts withstand the action of alkalies, soapy water and the heat from an electric element that warms the water. Resistant to corrosion, cracking, chipping and peeling, the dispenser is lightweight and possesses a smooth, glossy finish that will not wear off. Careful engineering of the piece was essential for rigid service conditions. Proper ribbing and wall structure had to counteract rough handling. The sleek black housing will contrast with the gleaming white of tonsorial shop interiors. More and more items for use in barber shops and beauty salons are being made of plastics. They give good service, clean easily, and always present an attractive appearance, with the result that the maintenance factor becomes unimportant.

Credits: Durez molded provided by Allover Mfg. Company.

PRODUCT DEVELOPMENT



Auto speed control

If you cannot trust yourself or members of your family to operate an automobile at a moderate rate of speed, then you will be interested in this safety speed control device which acts only as a speed control and does not rob the car of its efficiency in any other way. Employing phenolic laminated for several parts of the unit, the speed control mechanism is mounted under the hood of an automobile as shown (top) and may be set to limit the speed to any predetermined value. If the automobile is accelerated to a higher speed, the control automatically retards the speed of the vehicle. This unit functions in a completely different manner from that of the usual speed governor. It is operated by the speedometer cable and preserves the full power and acceleration of the car at all speeds below the set limit. The dependable operation of the speed control device relies, to a great extent, upon the important physical and electrical qualities of the laminated plastic material. The plastic is used for the laminated phenolic terminal plate (1), rubbing block insulator (2), terminal strip (3), the fiber insulating liner (4), and a canvas-base gear (5) shown in the inset.

Credits: Phenolite (laminated Bakelite). Unit is manufactured by Safety Speed Control Company.

Tissue dispenser

A toilet tissue dispenser molded in white of urea plastic and in black of phenolic material has just been put on the market. Molded in two parts, the body proper and the door, the unit is a completely hygienic dispenser that reduces maintenance care to a minimum. The lustrous plastic finish is permanent. A brief rubbing with a soft, slightly damp cloth is all that is required to keep the cabinet glistening. The unit will comfortably hold 1,000 sheets. When opened for a re-filling, the door fastened on top rests flat against the wall, providing easy access to the interior and leaving both hands free to place a new supply in the body of the cabinet. Another important feature is the upward slant of the slotted dispensing bottom, a type of construction which brings the projecting double-sheet into full view and does not permit it to fold back on itself. Openings on the back of the cabinet are for mounting and the bosses are for the uneven walls. The rear construction is rather interesting since it shows how the utmost in light weight was achieved. The unit measures 8 in. high, 5 in. wide and 3 in. deep.

Credits: Plaskon and Textolite molded by General Electric Co. for National Paper Products Co., Div. of Crown-Zellerbach Corporation.

PRODUCT DEVELOPMENT

Highway flare

Helping to reduce night accidents along dark stretches of heavily traveled roadways, car, truck and roadside reflectors, route indicators warning and directional signs and curve markers studded with clear plastic buttons have utilized to full advantages the excellent light collecting and reflective power molded methyl methacrylate. Based on the same principle, portable Miro-Flares, equipped with these plastic reflectors, keep danger at a distance whenever stalled trucks or autos pull off the road at night. Proof against wear and weather, the bright red reflector has a clear smooth face backed by a honeycomb of sharp-cornered cubes that flash back the rays of oncoming headlights both head-on and angular. This accurately molded disk won't flare at all in the sense of flaming, eliminating fire hazards, and it won't break or fade. Fitted into a compact container, the reflector stands upright in position, locked in place. The base formed by the sides of the case, folds up and over the reflector into a compact unit. Single units are available for passenger cars and a trio of flares is supplied for trucks to meet state requirements for commercial vehicles.

Credits: Molded of Lucite according to the Stimson principle. Manufacturer, Miro-Flex Company.

Miniature film viewer

Travel and adventure at home—insert a roll of film in the Tru-Vue, trip the lever and a three-dimensional appearing picture is flashed on a tiny screen. No larger than an ordinary pair of opera glasses, the molded phenolic viewer is much lighter. Redesigned, this sleek black model has sweeping lines and is constructed of only three parts. Two main pieces, the body and lid are produced in 6-cavity molds so constructed that the undercut part readily snaps off and requires no removable piece in the mold. Because of the demand for accuracy in these comparatively thin-walled pieces, they had to be cooled on "shrink" blocks. The red knob is made in a 10-cavity mold. Added economy is secured in assembly. The close-fitting lid snaps onto the body without fasteners. All assembly operations by "friction fit" replace machine screws, riveting and spot welding. The lenses are held in place by ingenious spring clips. The translucent windows in the front of the viewer are easily snapped in and out of molded-in seats and cannot be removed when the lid is in place. The trade name decoration is wiped-in in front.

Credits: Housing is Durez with a Bakelite knob. Molded by Barber Colman Co. Speed clips by Tinnerman Products, Inc. Designed by Gifford M. Mast

PRODUCT DEVELOPMENT

Picture frames

Ever since man made crude scratchings on the walls of a cave, pictures were used to depict life. In early years simple frames were used merely to focus attention and protect the art work. During the Renaissance, a picture frame became elaborate—hand carved of ebony, ivory, tortoise-shell, crystal, amber, mother of pearl, and even of silver and gold—so beautiful, in fact, that, more often than not, they became the center of interest. And then the pendulum swung the other way, and frames became not only plain but often unsightly. With the advent of small lithographed pictures, frames were required to lend size. Molded plastic frames have entered the scene now. Injection molded, in chaste laurel leaf designs, round cellulose acetate frames $6^{3}/_{4}$ and 5 in. in diameter are combined with convex glass for the line of Floral Jewel and Shadow Silhouette ornamental pictures. With no joints to open up, no applied surface finish to chip or crack, they are available in a wide variety of colors and are lightweight, strong and easy to keep clean. Since real flowers are used the frame is molded at an angle to accommodate the slope of the 1-in. domed glass.

Credits: Lumarith and Tenite injection molded by Chicago Molded Products Corp. for Convex Picture Studios

Plastics and rearmament

Rapid progress toward replacement of strategic metals with plastics for non-defense and military products has accelerated developments in materials and in molding technique. The importance of plastics in the defense program was emphasized at the Conference on Plastics which was held in Washington, D. C., Feb. 21, 1941, and attended by representatives of both government and industry. The papers which follow were among the important prepared addresses delivered and are presented in their entirety here because of the timely interest in their contents.

Impact molding materials

by ROY E. BERG*

AMONG the ever-growing uses to which phenolic plastics are being put by the military forces of the United States are many parts in which shock resistance or impact strength plays an important part as contrasted to those parts for which the cellulose-filled general purpose molding materials are entirely adequate. To meet this need there are available several different compounds, varying in inherent impact strength, which incorporate long-fibered fillers ranging from finely divided cotton fibers to shredded fabric. These shock-resistant molding materials may be designated as types 1, 2, and 3 in the order of their increasing impact strength.

Type 1 materials are readily molded and produce parts of high surface luster. They are used in the molding of plastic parts where an impact strength of 2½ times that of general purpose materials is advantageous. Parts molded of these materials are more resistant to boiling water than those of general purpose compounds. They are capable of being preformed on automatic tabletting machines with special feeding devices.

Type 2 materials possess an impact strength of approximately 5 times the general purpose type. They are not regularly controlled for electrical properties and are quite unsuitable for preforming on automatic tabletting machines.

Type 3 materials have the highest impact strength of the phenolic compounds and should be molded in truly positive molds. Their impact strength is approximately 15 times that of the general purpose materials. They are unsuitable for preforming except by hand.

It should be noted that the greater the shock resistance of phenolic molding materials the more difficult they are to mold. This results from the different bulk factors encountered in the types of filler employed. Consequently, the availability of a range of shock-resistant materials provides intermediate impact strength adequate for some uses without the unnecessary sacrifice of molding and (*Please turn to page 96*)

* Tech Art Plastics Co.

Plastic gas mask lenses

by MAJOR JOHN G. FLETCHER**

THE Chemical Warfare Service uses transparent plastic material in its Training Gas Mask facepiece and in its non-combatant gas mask facepiece. There is also a distinct possibility that transparent plastic material will be used in the Diaphragm Gas Mask facepiece.

The transparent plastic materials that have been approved for gas mask eyepieces include cellulose acetate, methyl methacrylate and vinyl resin. Eyepieces made from cellulose acetate or methyl methacrylate by injection molding are the ones used in the Training Gas Mask. The eyepiece of the non-combatant gas mask are cut from sheet or film cellulose acetate or vinyl material.

These materials have been selected because of the superior physical properties they possess as compared to those of the other transparent plastic materials which we have thoroughly tested. While these materials possess most of the characteristics required of items to be used in the field, they have several features that are undesirable in field equipment. The most outstanding undesirable characteristic of these materials is that they attract and hold dust particles. Due to the fact that a considerable amount of dust is almost certain to be present under field conditions, the vision of a soldier may be seriously impaired by the collection of dust on the gas mask eyepieces. In connection with this problem, there is the problem of resistance to scratching. In removing dust from plastic eyepieces, it is practically impossible to avoid scratching the surface of the eyepiece which in turn lowers its effectiveness for vision purposes. Greater resistance to scratching and a reduction in the attraction of dust particles are two things that will materially improve the usefulness of transparent plastic materials for Chemical Warfare Service uses.

On the credit side of the ledger, these materials possess sufficient strength, satisfactory light transmission, good optical properties and (*Please turn to page 86*)

** Chemical Warfare Service, War Department.

Freighter deluxe

PLYING its way between New York and South Africa, the *S.S. Robin Locksley*, the first of six new vessels to be built by the Seas Shipping Co., is one of the most smartly styled cargo vessels afloat. Her smooth, racy lines and novel color treatment without, vie with the luxurious and spacious accommodations for twelve passengers within. Plastics and other modern incombustible materials are used throughout the accommodations to provide maximum protection against the spread of fire.

Compact and symmetrical, the arrangement for passengers gives the utmost in privacy. Everything has been done to make the long trip to South Africa as pleasant and comfortable as possible. It is interesting to note that all of the interior styling and decoration for the ship was handled by interior specialists of the naval architect's own organization. It was felt that a complete understanding would thus be achieved between those responsible for the structural details on the one hand, and those handling the interior designing on the other, to save considerable time and expense.

Extensive use has been made of plastics for decorative purposes. Handsome methyl methacrylate lamps in three different designs are used in the verandas and in all the bedrooms. A large, modern clock of original design on the buffet in the lounge employs cast phenolic trim and an edge-lighted curved sheet of methyl methacrylate for the face. Light- (*Please turn to page 88*)

Luxuriously comfortable, the interiors of this new cargo ship (right) employ plastics for decoration coupled with resistance to corrosion and wear. Lamp on the table (below), of clear methyl methacrylate rods trimmed with twisted strips, is one of three styles found aboard. Laminated plastic surfaces most tables in lounge and bedrooms

Pastel Veneers

An important note in the interior design field long wearing plastic furniture veneers, thin, flexible, easily applied, are available in a wide range of colors

1

2

1—Highly practical and decorative for juvenile furniture, plastic veneers in gay colors are impervious to nicking, marring, scratching and will not warp or fade. Drawer pulls are cellulose acetate. **2**—New contours and curves for pianos are possible with this thin flexible material

A GLANCE at the history of fine wood furniture indicates that veneers play a very important part. In bringing veneers up to date according to the best 20th century traditions, we find a newly developed type of laminated plastic material that is causing quite a sensation in the furniture field. This product can be applied manually or mechanically to old or new surfaces and combines decorative qualities such as marbleized patterns, metallic or fabric textures and an unlimited color range with the rugged durability of synthetic resins.

This material is built up of layers of alpha cellulose paper impregnated with a light colored phenolic resin. The resultant veneer differs from the usual laminated materials in that it is only $^{20}/_{1000}$ in. thick and possesses a high degree of flexibility, thus permitting mechanical application to any flat surface or any curved surface of reasonable radii without the use of expensive dies or forms. These veneers are produced under pressure of 1500 lbs. per sq. in. at 270 deg. heat. Extremely hard and dense, the material is claimed to have a compression strength of 24M to 35M lbs. per sq. in. by test as against a compression strength of about 1M lbs. for wood.

Impervious to scratches, nicks and mars, furniture veneered with this new laminated material will have a long life. The delicate pastel tints in which the veneers are available belie its hidden ruggedness. Urea resins are used on the surface of the white veneers for protection and to prevent discoloration. To demonstrate the innate toughness of the veneer, a piece of furniture processed with the plastic was struck several sharp blows with a hammer. There was no visible damage to the plastic, but the wood beneath it was crushed. In another instance, keys were thrown upon the plastic surface and dragged with pressure across the top, but no marks were noticeable.

This laminated plastic is resistant to continuous heat up to 160 deg. F. Tests prove that lighted matches or burning cigarets (*Please turn to page 86*)

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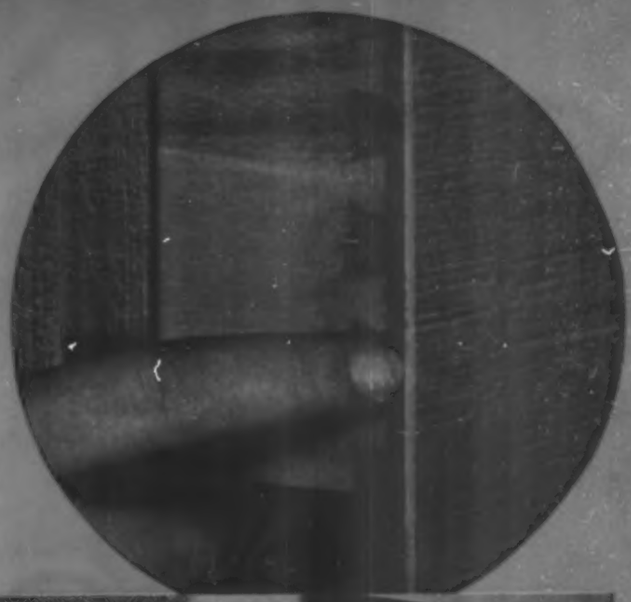

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3—Heat, stains, burns will not affect the finish of this bright dinette suite. 4—Unusual surface textural effects are achieved by a photographic process. 5—Thinness of the veneer is shown in bureau drawer top layer

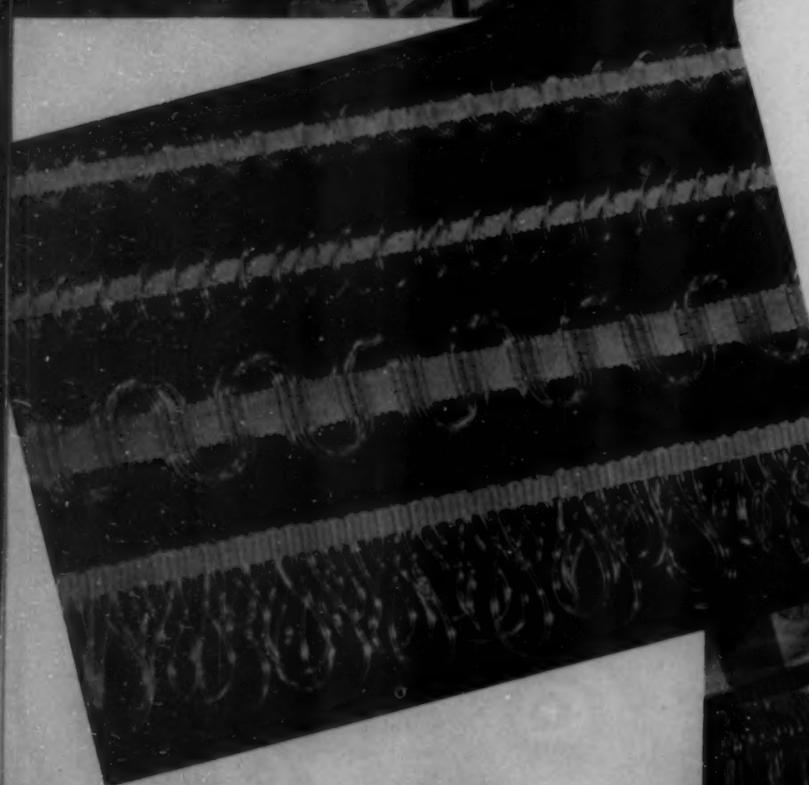
Tailored trimmings

1

SMOOTH, sparkling and sophisticated trimmings for upholstery, lamp shades and draperies, fabricated from thin glistening strands of vinyl material, prove that there is always something new under the sun particularly in the field of interior design. The extruded material comes in skeins of long transparent strands, like so much silvery knitting yarn, usually .07 mm. in diameter, the size used in hat trimming, evening headdresses and glamorous synthetic jewelry. A very thin strand, .046 mm., is also being used for a beautiful, flowing fringe that is highly decorative on draperies or ultra-luxurious lamp shades.

The extruded plastic is extremely flexible and may be braided or crocheted. The designer, however, has used the crystalline strands almost exclusively in looped fringe of different patterns and designs. For small lamp shades, for instance, he makes a short tight fringe in a "looped" effect. This not only provides a sparkling, decorative edge, but one that is water-proof as well. Deeper loops, either of even length or graduated, trim the binding on a deep-toned satin sofa or chaise longue, finishing it in a manner that is wholly unique because of the qualities of the plastic material.

One of the most practical uses for these vinyl strands is found in the tiny beading or binding, to take the place of welting in upholstery. Here the ruggedness and flexibility of the plastic are (*Please turn to page 80*)



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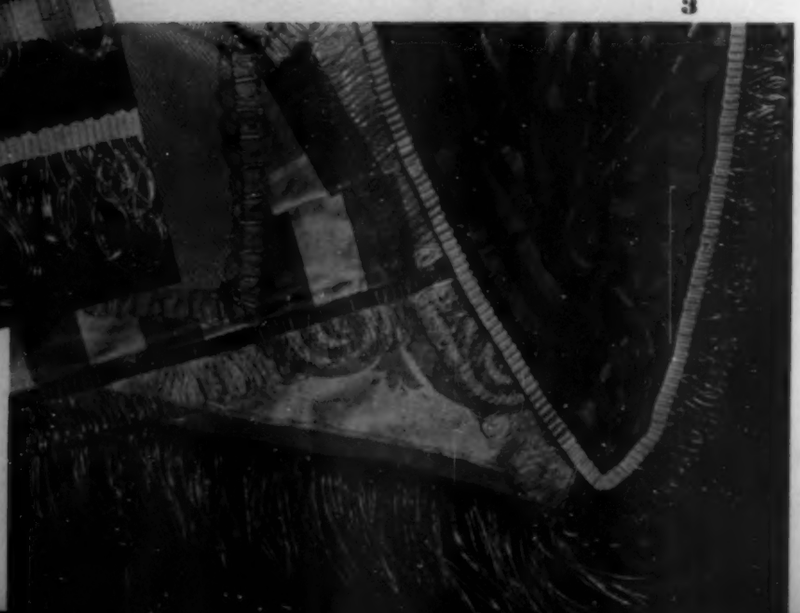

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Loops and circles and long, glistening fringe are among the many patterns that help to make up the wide variety of extruded transparent vinyl trimmings. 1—Short, stubby loops edge the lamp shade, while the chair and the sample of drapery material employ slightly longer lengths. 2-3—Close-up photos illustrate the wide design possibilities, also the unique beauty of the clear sparkling strands for these decorative purposes

Unbreakable, lightweight and washable, blown cellulose nitrate, long a favorite for children's toys, is being improved by American manufacturers and making great strides in eliminating foreign sources

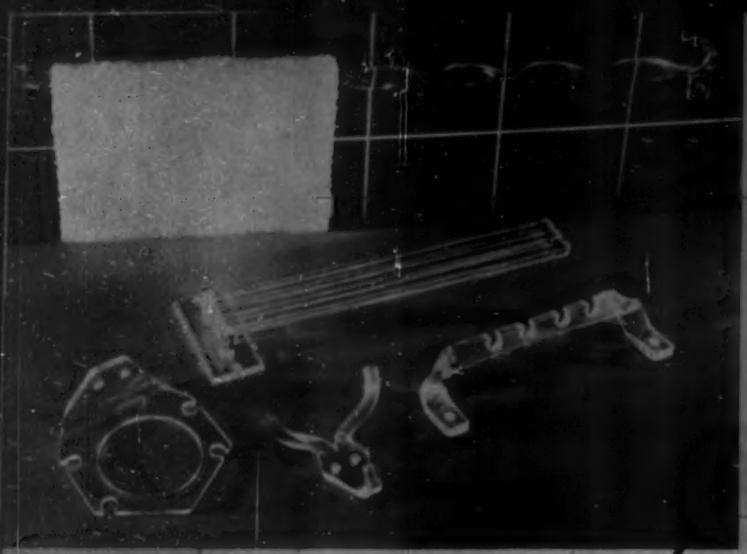
Toying with nitrocellulose

THE international ill winds blowing about the world today bring home to American manufacturers of plastic toys the truth of the axiom—"Tis an ill wind which blows no man any good." Nitrocellulose, the old timer of the industry, is stepping out once more in the extensive and profitable field of producing colorful blown toys, dolls' heads, rattles, floating fish, swans and many similar articles made from the material by the blowing method.

Very early in the development of this plastic both American and German toy makers exploited the art. Later when the Japanese plastics industry came forward as an important producer of nitrocellulose plastics, they followed in the footsteps of the American and German manufacturers in making toys with the result that they eventually had a commanding world position in the industry. With a cheap and an abundant source of camphor from their island possession, Formosa, plus extremely low labor rates, their production costs gave them an effective competitive advantage. In time they came to be the leading supplier for the American market, even surpassing Germany, who continued to hold something of her position by reason of the character and design of her articles accomplished mainly through the development of a superior die making technique.

Came World War II with Germany's toy makers eliminated as a source—came also Japan's declared allegiance to the Axis, with an attending disinclination on the part of the American public to purchase Japanese goods which amounted to a practical embargo—and the trade has had to turn to domestic producers. With the lid on the Old World and Oriental sources, American companies are benefiting.

The method of manufacturing toys by blowing is approximately as follows: Colored nitrocellulose sheets, 0.0015 in. thick and polished on one side, are placed together in forming dies which are then closed. Air is then blown between the sheets to force the material into the contour of the cavities. The heat and pressure causes the stock to become securely welded at the points of contact. Upon removal from the dies, the material has a high polish. The only finishing necessary is trimming. The blown heads of dolls and other toys are decorated by hand. Other parts are similarly treated (*Please turn to page 88*)



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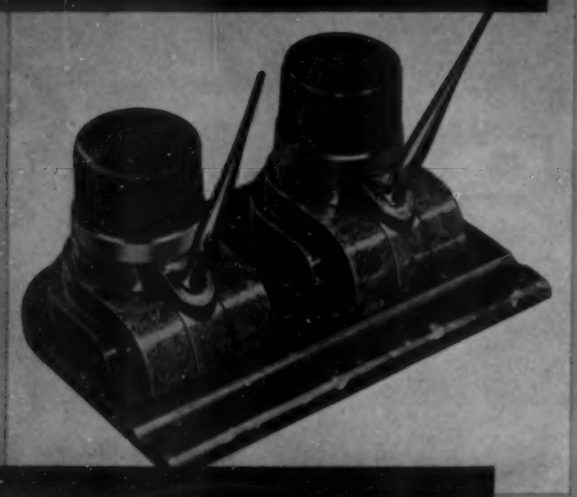

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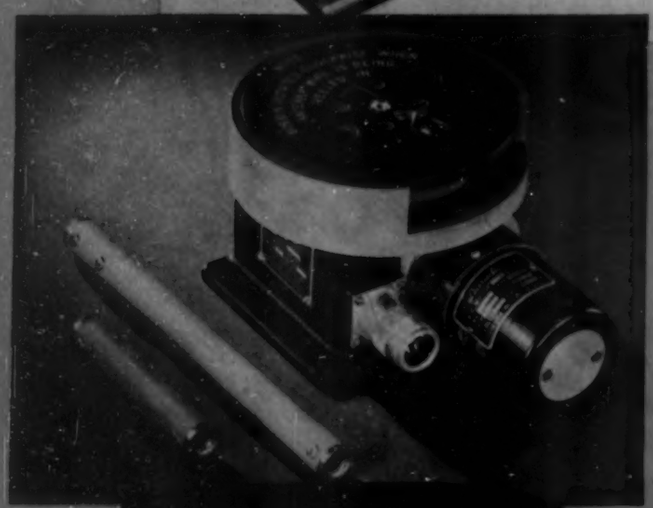

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Plastics

1 Fragile-looking but with the strength of Samson—clear Lucite accessories have been turned loose in the bathroom at everyday prices. A complete line of fixtures including towel racks, toothbrush, tumbler and toilet paper holders, soap dish, facial tissue box, clothes hooks, utility pegs and waste paper baskets have been fabricated from sheet and rod stock by Lucite Corp. Stain- and rust-proof, they're light and washable

2 Non-spillable, workable containers that keep ink clean and readily available are made in single or double units by Sengbusch. This Gee-Jay unit, in an attractive mottle that is well suited to most offices, is molded of Durez by Eclipse Moulded Products Company

3 Meeting rigid specifications for aircraft instruments, the automatic foulproof antenna reel by Lear Avia, Inc., is housed in fabric-base Synthane laminate made with Bakelite phenolic resin. Remotely controlled, the reel is used to let out and draw in a trailing antenna for radio transmission in flight. Therefore the material had to resist the drag of the antenna, withstand strenuous vibrations and a 12,000 volt breakdown

4 Sweeping rounded lines of the new Philco transitone are emphasized in the inherent gleaming finish of the plastic cabinet. Sturdy and lightweight, it is inexpensive to ship and easy to handle. Associated Attleboro Manufacturers, Inc., molds it of Resinox in a deep shade. Dial is set back for visibility. Knobs are molded plastic also

5 Loose connections in the darkest spots can easily be adjusted with Tul-lite—a tool handle with the light incorporated in the shaft. A beam of light is cast right on the job from inside the molded handle, and is transmitted through a clear plastic disk. There are no shadows or reflections cast and the other hand is left free with no flashlight or extensions to juggle. Resistant to oil, gasoline and electric current, the handle is molded of Tenite II by American Molding Co. Lucite end piece reflector is machined from rod stock

in Review

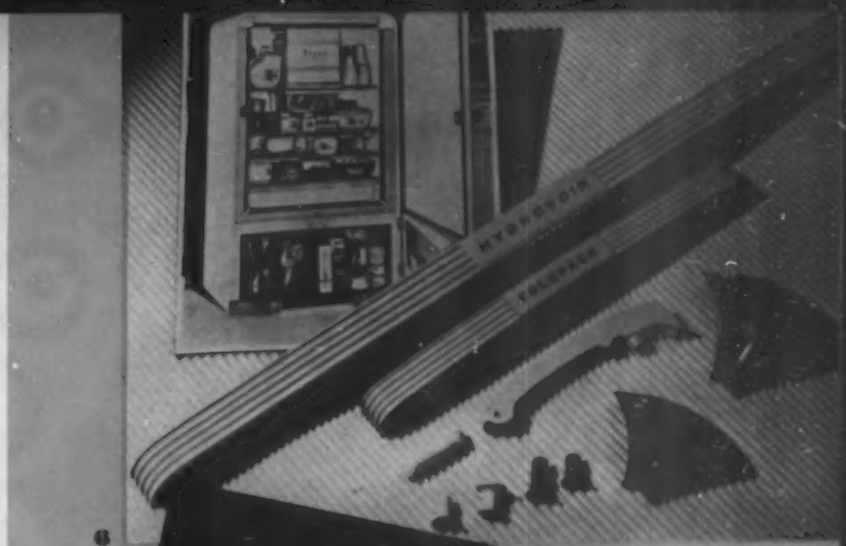
6 With light metal commissioned for national defense, plastics have been adapted for automatic refrigerators inside and out. Inherent color, economy, high dimensional stability, and impact strength at reduced temperatures, resistance to moisture, and odors are important. Corner pieces of gray to match frame are by Erie Resistor Co.; small freezer door handle by Detroit Macoid Corp.; shelf studs by Chicago Molded Products Corp. and National Organ Supply Co.; handles in foreground by Reynolds Molded Plastics, Inc.; latch handle by Winters & Crampton. All are Lumarith

7 Rain or shine, on dusty gravel or smooth concrete, molded Tenite auto club emblems ride the highways. Colors are all through and the surface will not chip, wear, corrode or warp. Contrasting wiped-in letters are legible against the ivory. Transparent amber-colored plastic centerpiece is backed with a metal reflector for night visibility. Molded by Plastic & Die Cast Products Corp. for Southern California Automobile Club

8 A novel display for dainty spring merchandise, this sparkling clear Plexiglas figure is sturdy and shatterproof. Light in weight and looks, it has a fresh, cool appearance which accents current styles. Designed and fabricated by Ray Dumont Studios for Saks Fifth Avenue

9 Aeroplane propeller blade made in laminated wood, impregnated with phenolic resins and cured under heat and pressure, as is regular laminated plastic. It is then machined resulting in a light strong piece. The blade has good dimensional stability, is not subject to corrosion or similar deterioration. The material is Formica pregwood

10 A classical cameo motif centers interest in the decorative and durable Nutone chime housing. Economical, they are injection molded of Lumarith by Elmer E. Mills Corp. in neutral shades which blend with modern or traditional interiors. Light but tough, they are safe in transit, during installation and general use



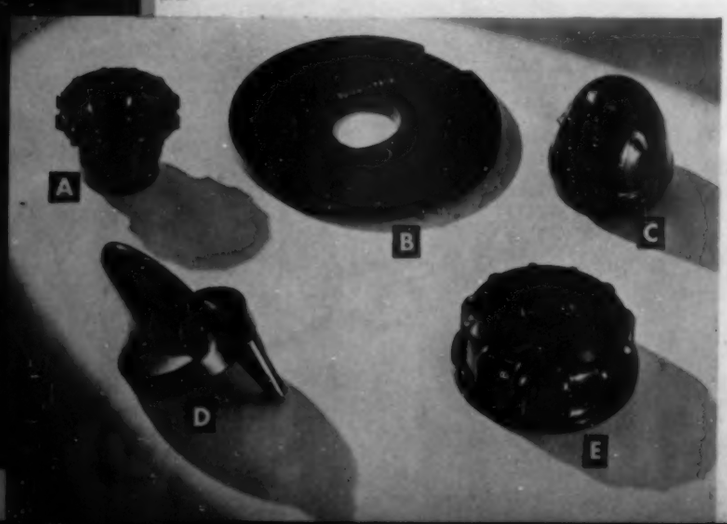
Plastics

11 Darting gleams of light on the water reflect on these molded fluorescent acetate fish lure plugs causing them to change color and glow in terrifying, lifelike fashion. They're molded in varicolored Lumarith by Dillon-Beck Mfg. Co.

12 Dainty transparent cigaret cases molded of Crystalite are lightweight, shatterproof and in complete harmony with feminine style trends. They're made in attractive colors—bright blue, dusty pink, blond and scarlet by Henriette, Inc., and there are smart compacts to match. Molded by Belmont Molded Plastics, Inc., and Metal Specialty Company

13 Even a "he-man" has to be neatly groomed. Kamoflage disguises his personal equipment with a clipped fountain pen barrel top that actually conceals a nail file and comb tucked conveniently in a pocket. There are colors to match most pen and pencil sets. Earl S. Tupper molds it of Lumarith. The file fits inside the comb top

14 Evinrude outboard motors, as the Lightfour model below, substitute plastics for aluminum and metal parts with improved design, resistance to moisture, durability and economy. Threaded gasoline tank filler caps (A, E) and steering handle knob (C) work smoothly without sticking. Pump deflector (B) resists salt water corrosion. Carburetor control dial (D) has a lasting finish that does not discolor in use. They're molded of Bakelite phenolic by Eclipse Moulded Products Corp., Chicago Molded Products Corp. and Imperial Molded Products Corp., respectively. Individual parts are shown separately below



15 To haunt or delight in years and years from now, prints and negatives will be preserved intact in the Seeclear Fotofolio album. Transparent Ethofoil sheet forms the envelopes in which the photographs are filed. Manufactured by E. E. Miles Company

in Review

16 Shake them and roll them again and again without marring, chipping or dimming of luster. Durable Kelly pool buttons have numbers molded right in so they cannot wear or rub off. Burt Co. molds the buttons of Resinox

17 Swanky blue ribbon winner or playful hound, your pup can be comfortably controlled with an automatic leash. By simply pressing a small switch on the case, the leash can be let out to any desired distance. It is wound on a spring reel encased in Tenite. A large integral handle forms a convenient grip for the device. Chicago Die Mold Mfg. Co. molds it for Inventors Products Corporation

18 Housed in a handsome brown mottle cabinet with contrasting light colored dial and tuning knobs, the new Sonora 5-tube superhet radio is unique in design. No aerial is required. The case measures $11^1/_2$ in. by $6^3/_4$ in. by $6^1/_2$ in., and it has a deep tone. Molded of Durez by International Molded Plastics Company

19 To prevent bacteriological contamination of rubber nursing nipples, Sterilon shields are used to apply nipples to infant's bottles in sanitary fashion. Said to be resistant to prolonged boilings, sudden temperature changes, and chemically inert, the molded plastic shield is transparent, smooth and practically unbreakable. Wheeling Stamping Co. molds it of Bakelite amber phenolic

20 Decorating the TWA Directors' room in the New York Airline Terminal, this map indicates principal airline routes by thin strips of clear cellulose acetate, set on a copper map of the United States. Red fluorescent acetate strips emphasize the TWA route and cities are shown by Lucite buttons pegged through the copper and illuminated from the back. Map is set forward about 4 in. from the painted canvas background. Size is about 3 to 4 ft. Designed by Richard Gaige

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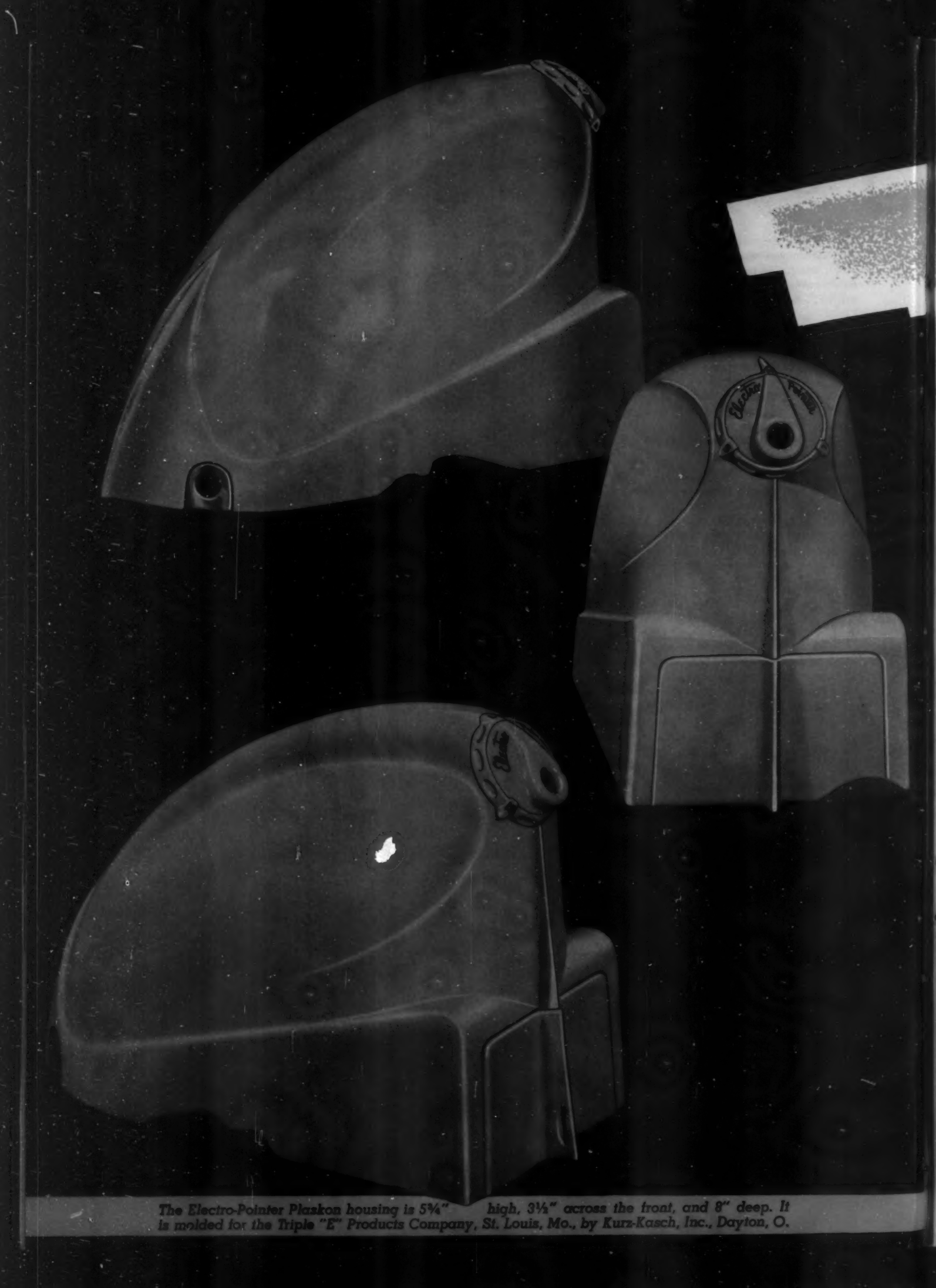

The Electro-Pointer Plaskon housing is 5¼" high, 3½" across the front, and 8" deep. It is molded for the Triple "E" Products Company, St. Louis, Mo., by Kurz-Kasch, Inc., Dayton, O.

Electro-Pointer... the most modern of all new business machines...beautified with Plaskon Molded Color

Now pencil-pointers join the plastics parade!

In today's march of business equipment toward the goal of greater beauty and efficiency, the Electro-Pointer pencil sharpener takes a prominent place.

The Electro-Pointer heralds the passing of the last vestige of "horse-and-buggy" equipment in the modern office. The streamlined beauty of its Plaskon Molded Color case complements the amazing efficiency of the mechanism it contains. Sharpening a pencil has become as easy as dipping a pen, thanks to Electro-Pointer.

Plaskon Molded Color was chosen for Electro-Pointer housings because of its many advantages. The smooth, hard, lustrous finish cannot be marred or scratched. And the several rich Plaskon colors in which Electro-Pointer cases are offered remain unchanged in depth of tone year after year.

Plaskon gives the advantage of light weight to the Electro-Pointer, yet provides adequate strength to resist breakage. Plaskon will not corrode, rust or tarnish, even under unusual atmospheric conditions.

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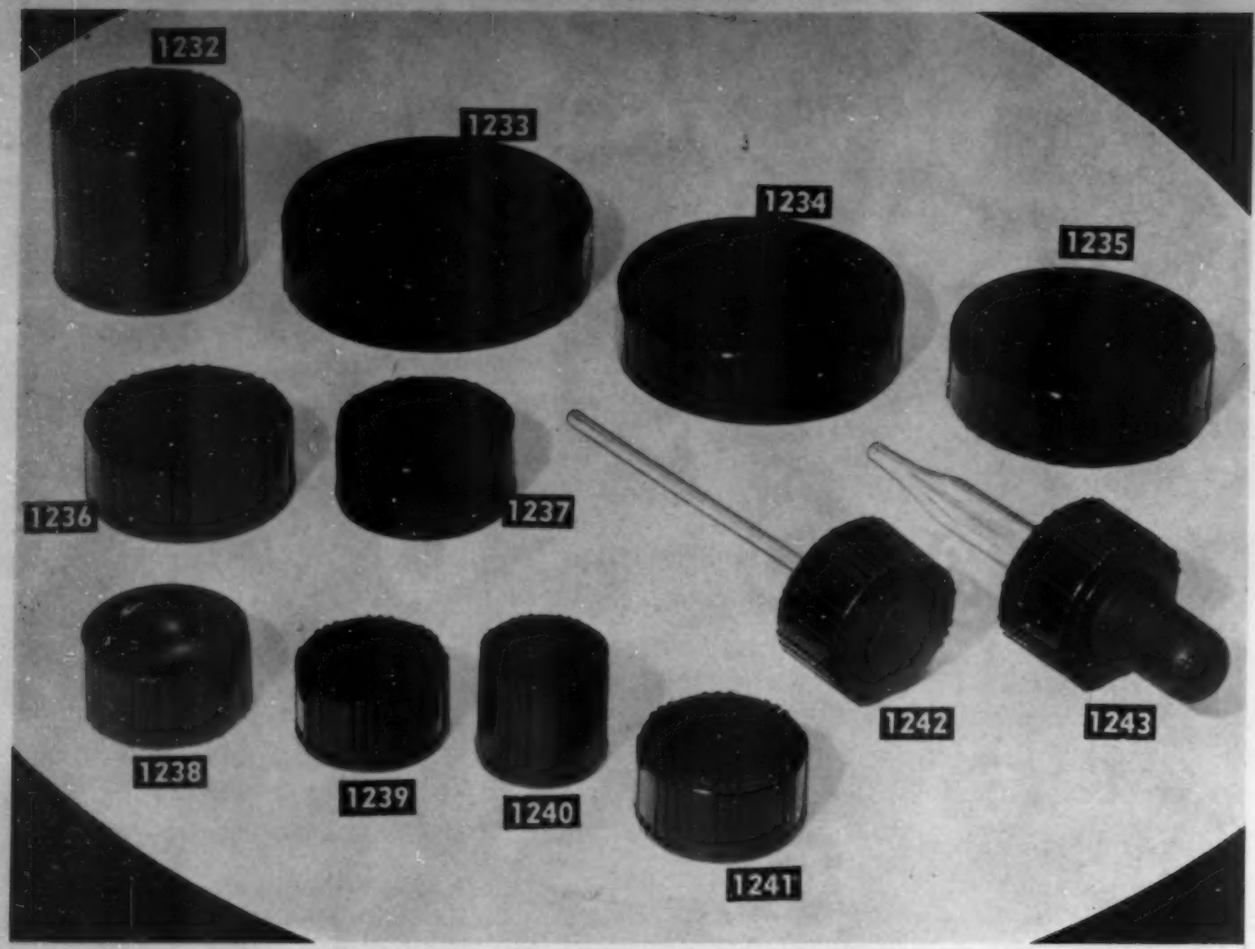

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1241. Threaded 20 mm. cap. Overall diameter 7/8 in.; 7/16 in. high

1242. Threaded 20 mm. cap. Overall diameter 7/8 in.; 1/2 in. high. Oval opening on top into which fits rubber head which holds glass capillary applicator

1243. Threaded 20 mm. cap. Overall diameter 7/8 in.; 1/2 in. high. Glass dropper and rubber bulb inserted through opening

All molders are invited to send samples from stock molds to appear on this page as space permits

Aircraft plywood and adhesives[1]

by THOMAS D. PERRY[2]

PLYWOOD, as a structural material, has a utilization history of about fifty years. Decorative and artistic face veneers, always more or less fragile, had been reinforced by under layers of sturdy wood since the time of the Pharaohs in Egypt some 1500 B.C.

The design requirements of early aircraft, in the first decades of the present century, were the first real exploration of the strength/weight ratio advantages that have become so characteristic of well-designed plywood. In fact, the term "plywood" did not come into use until about this time. While plywood is made of *veneer*, the unfavorable and accumulated connotations of that word, obliged plywood advocates to establish the better and more descriptive title, *plywood*, which was particularly suited to strength factors of such a multi-layered product. Many other advantages of plywood, such as non-splitting, dimensional stability, distributed strength, cost, availability, ease of working, conservation of timber, facility for curving, bending and forming, need only be listed here, as they have been adequately described elsewhere (5).[3] With its many advantages in aircraft construction, there were a few limitations in plywood utilization that were recognized as serious handicaps in World War I.

One of the disadvantages that has been imputed to plywood, but quite incorrectly, was its tendency toward inflammability. It is perfectly apparent that the major hazard in flight is the gasoline fuel. If this becomes ignited, at any point, it matters little whether the plane is made of fabric, plywood, wood or metal; the results are equally disastrous. Experience has changed opinion on this point, due partly to better safeguards against fire, and it is no longer considered an unfavorable factor in the use of plywood aircraft.

The other major limitation to wood and plywood construction, in this early period, was the character of the adhesives used in making the plywood and in assembling the wood and plywood parts. The adage of the weakest link in the chain was a singularly accurate analogy to the quality of the adhesive used in the plywood.

In order to get perspective and intelligently evaluate the excellent plywood adhesives of the present time, it is important to briefly outline the background of the adhesives that were available at the time of World War I. At that period, *casein* (made from the curds of soured milk) and *albumin* (a dried blood product coagulated under heat) were considered the most durable adhesives for aircraft construction (11). Neither would withstand even an elementary mold and fungi test; in fact, under suitable conditions, both encouraged such parasitic growths. Casein plywood, bonded cold and tested dry, gave excellent bonds, and the addition of lime, up to 15 percent, improved its water resistance, but made it abrasive on edge tools. At best its resistance to continuous soaking and to alternate wet and dry tests was relatively low. It failed quickly in boiling water. Albumin plywood, hot pressed, possessed unusual water resistance, in fact could be soaked for many days, and would resist several cycles of wet and dry tests. It was not abrasive on tools, but it was found to deteriorate seriously with age.

In spite of these limitations plywood continued to be extensively used in aircraft for some years after the War (9), but it was gradually displaced by metal. This was due, to a considerable extent, to the better cooperation between metal workers and the aircraft industry than was the case with the plywood makers. The metal advocates evidently were more research minded and more eager to develop the necessary scientific strength data than were the plywood group.

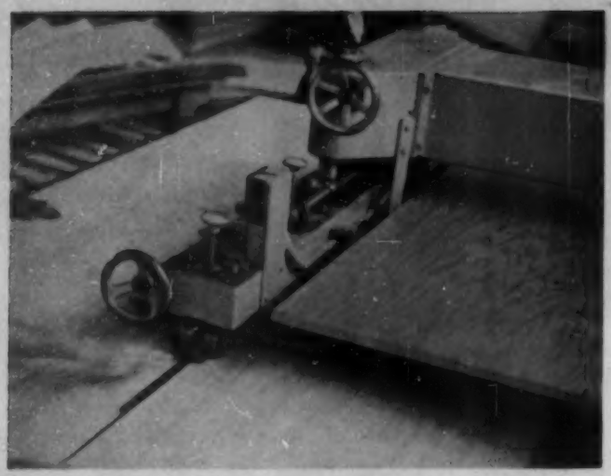
Soon after 1930, with the rapid growth of the plastics industry, resin adhesives began to attract the attention of the plywood industry. At first the phenol-formaldehyde resin was the only one available and that in film form (14) on an import basis. While only a few hot presses were available, the hot pressed resin plywood gave convincing evidence of far better durability than either casein or albumin, but the high import cost retarded the growth of the resin adhesive program.

By 1935 the demand for phenolic resin film was sufficiently urgent to justify domestic manufacture, which soon reduced the price to about half that of the imported supply, a typical American experience (17). With this impetus, and the excellent durability characteristics that were found in resin-bonded plywood, the aircraft industry began to renew its interest in plywood (18). These improved durability factors were:

[1] Paper presented at the Annual Meeting of the Institute of the Aeronautical Sciences, January 1941.

[2] Development Engineer, Resinous Products & Chemical Co.

[3] Bibliography references are indicated by parenthetical ( ) numbers in the text.



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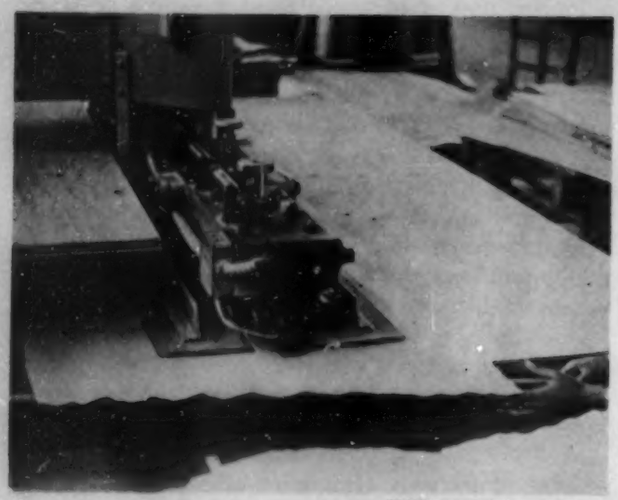


2

PHOTOS, COURTESY PLYCOR CO.

These photos show edge splicing veneer without tape. 1—Infeed side of splicing machine. 2—Delivery side

1. Complete waterproofness, adhesive insoluble until wood decays.
2. High resistance to bacterial growth.
3. Boil proofness, facilitating bending and curving after steaming.

The liquid phenolics, developed several years after the films, were also found to possess the same durability characteristics. This development of phenolic adhesives removed the principal objection to the use of plywood in aircraft.

Technique of hot-pressed resin bonding

The technique of bonding with film is definitely simpler than the mixing and spreading of a liquid, although both methods are practiced. The interleaving of the dimensioned film between veneers of 8 to 12 percent moisture content is the only preparatory step required (28). In the case of a phenolic solution the successive steps of mixing, spreading and pre-drying (to prevent steam blisters in hot pressing) are necessary steps before pressing. In either event, the assembled sheets of veneer and adhesives are subjected to simultaneous heat and pressure for an interval varying from 5 min. for $^1/_{16}$ in. to 12 min. for $^5/_{16}$ in. plywood, at 300 deg. F. and a pressure according to the density of the wood, from 125 lbs. per sq. in. on spruce to 250 lbs. per sq. in. on birch. Resin adhesive technique requires more care and precision than was considered necessary with the older glues.

The effect of the thickness of the veneer layer on the strength characteristics of the plywood shows some interesting trends, although the test data are inadequate for other than general conclusions (46). Table 1 gives the comparative results. The plywood samples were made of birch veneer under 500 lbs. per sq. in. pressure, somewhat higher than normal. Improvement is negligible between $^1/_8$ in. and $^1/_{16}$ in. veneer, but conspicuous from $^1/_{16}$ in. to $^1/_{48}$ in. Interpolation would suggest that $^1/_{30}$ in. veneer would give excellent strength increments, but this remains to be confirmed.

While the above procedure ordinarily applies to plywood made flat, it is equally practicable to preform (during the bonding operation) a wide variety of plywood shapes in pairs of heated metal dies. This is limited, of course, to such a range of shapes as will not rupture the veneer, the layers of which may be reinforced by thin cross layers of fabrics. Flat plywood, within reasonable limits, can be steamed thoroughly, formed and dried in wood or metal dies, the use of heat being optional and depending on the speed required. Bending without wood rupture can often be facilitated by placing veneer layers at 30 or 45 deg. to the axis of curvature. A wide range of constructions is available for use in bending operations, with variations in thickness of veneers, grain directions, compressibility factors and the like.

One of the earlier difficulties in aircraft plywood was the gummed tape that was used to hold the sheets of veneer together, edge to edge. The narrow ribbons of paper weakened the plywood joint, due to the tendency of the paper to delaminate. Edge gluing equipment for veneer has recently become available, using heat reactive resins. The details of this operation are shown in Figs. 1 and 2. The liquid resin is applied to the edges of the veneer as it enters the gang of rollers, a brief drying interval follows, and the partly dried resin is cured by heat applied through the rollers at the outfeed end of the machine. The speed of operation on such

TABLE 1.—EFFECT OF VENEER THICKNESS ON PLYWOOD STRENGTH

Plywood bonded with Tego Phenolic Film at 500 lbs., with alternate cross layers

Key	Veneer Thickness	Layers Used	Specific Gravity	Compression	Tension	Shear
A	Solid Birch	1	.63	6,200*	10,100*	2,020*
B	$^1/_8$ in. Birch	9	.77	7,890	11,840	6,060
C	$^1/_{16}$ in. Birch	17	.72	7,980	13,920	6,330
D	$^1/_{48}$ in. Birch	69	1.05	11,720	19,160	11,540
	Increases					
	D over A*	...	67%	89%	90%	470%
	D over B	...	46	49	62	90

TABLE 2.—EFFECT OF INCREASING BONDING PRESSURE IN PLYWOOD

Plywood of 1/48 in. birch veneer, with alternate cross layers, using single sheets of Tego Resin Film

Key	Construction	Layers Veneer	Specific Gravity	Specific Pressure	Compression	Tension	Shear
A	Solid Birch	...	.63	...	6,200*	10,100*	2,020*
B	Birch Plywood	57	.77	200	8,580	12,550	7,240
C	Birch Plywood	69	1.05	500	11,720	19,160	11,540
D	Birch Plywood	81	1.30	1,000	14,220	25,740	16,180
E	Birch Plywood	85	1.35	1,500	14,410	26,760	16,130
	Increases						
	B over A*	..	22%	...	38%	24%	258%
	E over A*	..	114	...	132	166	700
	C over B	21%	36	...	37	53	59
	D over B	42	69	...	66	105	124
	E over B	49	77	...	68	114	122
	D over C	17	24	...	21	34	40
	E over C	23	29	...	23	40	40
	E over D	5	4	...	1	4	0

Pressures and strength factors in pounds per square inch.

* Strength factors of solid wood and plywood not strictly comparable, but this fibre stress at the proportional limit in solid wood is the most available figure to compare with breaking stresses in plywood of this type.

machines may be around 100 ft. per min. on thin veneers. The resulting edge joint is as strong as the veneer, and is difficult to distinguish. Such equipment is coming into quite general use in plywood factories.

High density plywood

The processes so far described apply to what is termed normal plywood, where the density of the wood may be somewhat increased by the addition of the resin and the slight compression (approximately 5–10 percent) of the veneers required to bring the surfaces into intimate contact for positive bonding.

Further compression, with higher specific pressures during the bonding operation, imparts an entirely new range of strength properties as can be noted in Table 2 and Fig. 3 (46). The thickness of the test pieces was a full inch after compression, requiring additional sheets of veneer as the pressures were increased, as indicated in the third column of Table 2. The higher density samples were cooled thirty minutes before the removal of pressure. It is noticeable that the increases in specific gravity and strength were, in general, about double the increases in amounts of raw material required; except between 1000 and 1500 lb. pressures, where the improvement was not significant. In other words, both the table and chart indicate that a distinctly lower rate of increase is to be expected over 1000 lbs. The tests were made on plywood from sheets of 1/48 in. birch veneer, with alternate layers crosslaid. Consequently the resin impregnation throughout the veneer was reasonably complete. It was discovered, somewhat unexpectedly, that poplar, compressed under the same pressure, showed substantially the same specific gravity and had approximately the same strength factors as birch. It required, however, 105 sheets of 1/48 in. poplar to produce a 1 in. thick sample of 1500 lbs. pressure. This would appear to indicate that wood at high densities is quite independent of original species characteristics.

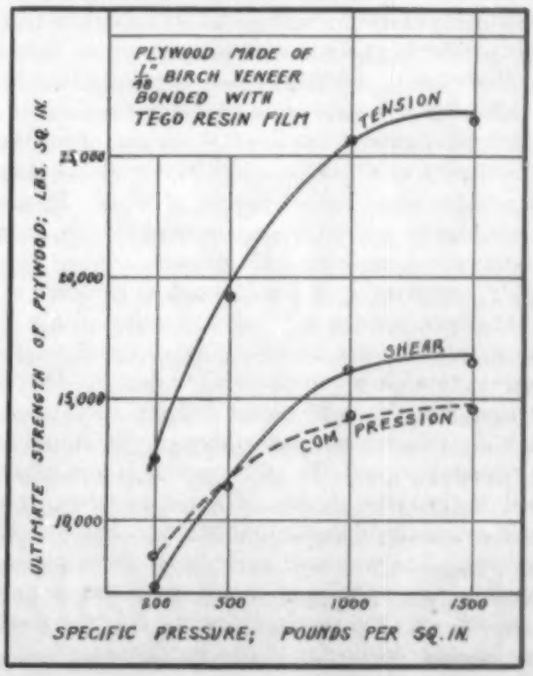
This high density plywood can also be made by impregnating the veneers with a liquid phenolic resin, predrying and then hot pressing as in the case of film (24, 25, 31). While this process is considerably more complicated, it will give a more complete impregnation. In general, it may be said that the use of film results in wood reinforced with resin, with wood characteristics predominating, while the use of liquid resin produces a plastic reinforced with wood, more closely approaching the physical characteristics of plastics. The plywood made by both processes, when soaked, tends to expand part way back towards its original thickness, but its absorptive capacity is far less than in normal plywood. This favorable change in plywood strength characteristics through increase of density, is somewhat analogous to the alloying and heat treatment of metals to improve their qualities. It gives to wood workers an opportunity to meet design requirements that are far beyond the range of normal wood or normal plywood. The strength characteristics of this high density plywood have been only partly explored and published (25, 26, 42, 44). More work is in process and results will be published as fast as they are available.

Assembly adhesives

Plywood adhesives, as they have so far been considered, are adhesives that can be applied on veneers over large areas and bonded flat or curved, by the simultaneous application of heat and pressure. The most durable plywood, from all viewpoints, is that made with phenol-formaldehyde resin adhesives. Adequate machinery has been developed so that flat and moderately curved plywood can be made economically.

The other major adhesive problem in the aircraft program is that of the many manual operations of

3—Strength increases in plywood with higher specific pressures



putting parts together, where a suitable adhesive is admittedly superior to any type of metallic fastener, such as nails, screws and bolts. In this field casein had been found the best of the glues available up to the early 1930's when the last specifications (50, 51) were established for the assembly of airplane parts. Its serious limitations have become increasingly evident, especially in the last year, since plywood interest has again been awakened in the airplane industry. Casein may be as strong as the wood when dry and is water resistant, but delaminates after limited soaking in cold water, and very quickly in hot water. It is abrasive for cutting tools, and is low in resistance to bacterial growths.

Resin adhesives fortunately possess the good qualities and lack the poor qualities of the caseins. Dry bonds of both adhesives, if properly applied, will break in the wood. Resins now available for airplane assembly purposes are sufficiently water resistant. Test samples after three months' continuous soaking still retain over half of their shear strength. In the mold and fungi test casein is practically delaminated in the 10-day test, while suitable mixtures of resin pass the 10-day bacterial exposure with a 250-lb. shear test. In the matter of abrasiveness the resins are far less damaging to edge tools than the caseins.

The phenolic resins, with the quality characteristics that have been outlined for plywood, have not yet found general favor in assembly work, as their low heat reaction is definitely inadequate. Fortunately another group of resins, the urea-formaldehyde type, are well adapted to assembly purposes. With a proper catalyst, the mixtures are stable or "live" for 4 hours after mixing, and will cure at room temperatures of 70 deg. F., although the quality of the bond is improved and its cure accelerated by the application of heat up to 140 deg. F. while under pressure, for a 4 to 8 hr. period. These urea resins come in liquid form, which is reasonably stable for storage before catalyst is added, and in powder form, with catalyst incorporated, in which case the storage possibilities are definitely increased, provided the powder is protected from moisture. It is often advisable to use a small amount of relatively inert extender as a "body-maker" to reduce the absorption into the more porous species of wood. Pressures for this type of cold-setting resins need only be enough to bring wood surfaces into intimate contact, or to slightly compress such a soft wood as spruce.

It has been pointed out that urea resins, with a cold-setting catalyst, are benefited by elevated temperatures, up to approximately 130–140 deg. F. One way to accomplish this is an air-conditioned chamber, into which jigs, clamps and assemblies can be stored over the required period. In such cases it is important to guard against the drying of wood members, which should retain their normal moisture to preserve their resiliency. The wet and dry bulb readings, necessary to maintain an equilibrium moisture content, are given in Table 3, over the required ranges. It is also a useful table for air-conditioning of any wood shop.

A similar type of urea resin (34) is also available for hot pressing, where temperatures of 230 deg. F. to 260 deg. F. and specific pressures of 100 lbs. sq. in. and up can both be obtained simultaneously, as in standard flat plywood. Its use in aircraft plywood, however, is to be discouraged, since the phenolics give a more durable bond at slightly higher temperatures, and the phenolics are boilproof, heatproof and far more resistant to continuous and intermittent soaking.

Molded airplanes and sub-assemblies

There has been much publicity on the subject of plastic airplanes, a somewhat inaccurate description, as the airplanes so far made have been molded plywood with resin adhesives and finishes, which hardly justifies the use of the comprehensive term plastic airplane (48*b*). The principles involved in molding plywood are old, and the only novel features were the methods of applying the pressure as well as the unusually large size of the molded unit. The fundamental principle involved is that of using an inflated or deflated rubber bag as one of the halves of a pair of molding dies. There is not only the saving in matching up a pair of dies where the intermediate distance between halves must be very accurately determined, but in many cases the dies are wholly eliminated. In any event, rubber bag pressure is of the order of fluid pressure and at substantially right angles to any surface that is under pressure. The Duramold, Timm and Vidal processes all utilize this rubber bag pressure principle.

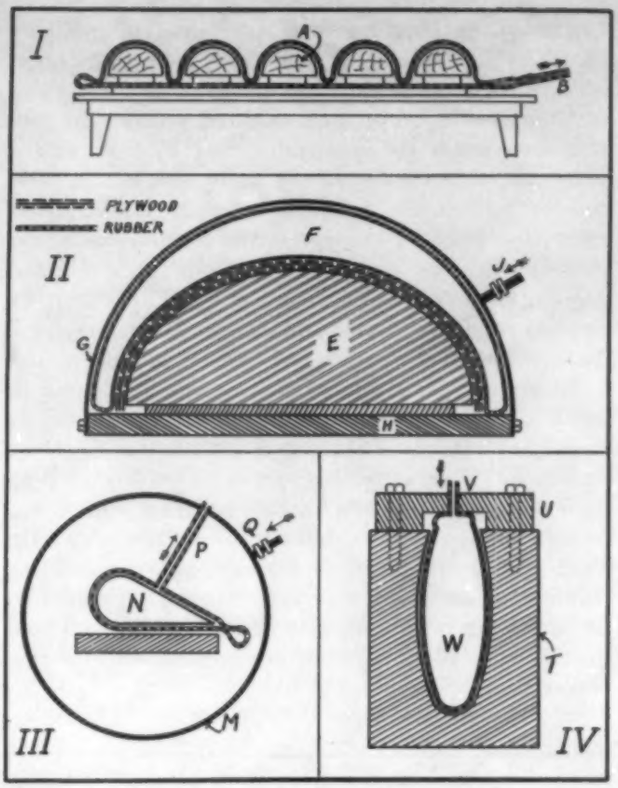
TABLE 3.—EQUILIBRIUM MOISTURE CONTENT OF WOOD PRODUCTS
At Various Dry and Wet Bulb Readings

Dry Bulb Temperatures, Deg. Fahrenheit	Equilibrium Moisture Content of Wood											
	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
	Wet Bulb Temperatures, Deg. Fahrenheit											
50	34	36	38	39	40	41	42	43	44	45	46	46
55	39	41	42	43	45	46	47	48	49	50	50	51
60	43	44	46	47	49	50	51	52	53	54	55	56
65	46	48	49	51	53	54	56	57	58	59	60	60
70	50	51	53	55	57	58	60	61	63	64	64	65
75	53	55	57	59	61	63	64	66	67	68	69	70
80	56	58	60	63	65	67	69	70	72	73	74	75
85	59	63	64	66	69	71	73	75	76	77	78	79
90	..	65	68	70	73	76	78	79	81	82	83	84
95	..	69	72	75	78	80	82	84	85	87	88	89
100	..	..	76	79	82	85	87	89	90	92	93	94
105	..	..	80	83	86	89	92	94	95	96	98	99
110	..	..	84	88	91	94	96	98	100	101	103	104
115	..	..	..	92	96	99	101	103	105	106	107	109
120	..	..	..	97	100	103	106	108	110	111	112	114
125	..	..	..	102	105	108	111	113	115	116	118	119
130	..	..	..	107	110	113	116	118	120	121	123	124
135	..	..	..	111	115	118	121	123	125	127	128	129
140	..	..	..	116	120	123	126	128	130	132	133	134
145	..	..	..	121	125	128	131	133	135	137	138	139
150	..	..	..	126	130	133	136	138	140	142	143	144
155	..	..	..	131	135	139	142	144	146	147	148	150
160	..	..	..	136	140	144	147	149	151	152	154	155
165	..	..	..	141	145	149	152	154	156	158	159	160
170	..	..	..	146	151	154	157	159	161	163	164	166

Examples:

A What air conditions are required to maintain veneer at 10 percent moisture content for Tego film bonding? At 90 deg. F dry bulb, set humidifier for 78 deg. F on wet bulb.

B In an oven, where clamped cold-set resin assemblies are placed over night, if moisture content of the wood is to be kept at 12%, and oven heat is 130 deg. F (dry bulb); set regulator for wet bulb of 120 deg. F.



4—Typical diagrammatic sections (no scale), showing molding processes for aircraft. I—With vacuum bags: A. Solid wood pilasters to be veneer faced. B. Vacuum exhaust outlet. II—Half Fuselage: E. Inside mold, may be metal with steam pipes, or framed wood with slots for rings and longerons. F. Rubber bag, inflated with air, steam or hot water, through inlet J. G. Outer steel shell, bolted to base H. III—Subassembly parts in pressure tanks: M. Outer steel tank. N. Subassembly, inside of rubber bag. P. Vent to atmosphere, or vacuum connection. Q. Pressure connection for steam. IV—With internal bag pressures: T. Outside mold, metal or heavy wood frame. If of metal may be steam heated. U. Sturdy camp, bolted to T. V. Inlet for air, steam or hot water. W. Rubber bag, inside of subassembly. Applications for these molding processes are more fully described in the text. There are other possible molding techniques adaptable for aircraft design

Several of the more important applications of these rubber bag pressure principles are shown in Fig. 4. The upper sketch (Fig. 4-I) shows an early type of vacuum bag, used with cold-setting glues, for the facing of wood-core pilasters with veneers. The wood cores are accurately machined and very thin veneers are used. After the adhesive is applied, the parts are assembled and inserted in the rubber bag where the pressure is reduced to an approximate vacuum. While this pressure cannot exceed 15 lbs., the manual pressing and rubbing of the veneers against the cores, through the bag, will help to smooth out the curves. Quick-setting glues of a tacky nature hasten this operation.

The next sketch (Fig. 4-II) indicates a method that has been used to mold half-fuselages. Here the inner mold may be made of metal or wood, and, if metal, may be provided with heating units. The outer shell must be of sheet metal, substantially cylindrical in shape, and firmly bolted to the base plate on which the inner mold rests. The wood parts, to be molded, may be of veneer or plywood, but must be cut to such tapers that each layer covers the preceding one completely and without laps. These parts must be held in approximate locations by tacks (if a wooden mold), paper or cloth tape, steel bands or wire. A deflated rubber bag, somewhat like an air mattress, is placed over the freshly spread wood layers, and the outer shell is dropped over the whole and bolted to the base. The rubber bag is then inflated with air, hot water or steam, and the wood layers are pressed and bonded together as well as to the frame members inserted in the mold. This method has been successful in making plywood hulls for small boats, using an inside mold of skeletonized wood, in which ribs are set flush for bonding to plywood.

Another process of molding plywood parts is shown in Fig. 4-III, in which a subassembly is enclosed in a rubber bag and the bag placed in a pressure tank. No vacuum is necessary here, merely a vent to atmosphere. The tank is usually filled with steam at 50 to 100 lbs. pressure. This method can be applied to such subassemblies as wings, ailerons, tail parts, etc., where plywood skin covering can be bonded direct to skeleton frame, spars, ribs, etc., without nailing, except the minimum necessary to hold parts in position until they are bonded.

The fourth type (bottom sketch Fig. 4-IV) is substantially the reverse of II, with a rubber bag placed inside rather than outside of the plywood to be bonded. It is useful where several layers of 2-ply are to be glued together after bending, and bonded into a rigid leading edge. This cannot be done in III, because of inadequate pressure where plywood is not supported by frame work. One of the distinct advantages of this outer-form-inner-bag method is the smoothness of the outside surface, with all irregularities occurring on the inside, adjacent to the bag.

These several molding methods have distinct possibilities, and there are many other possible combinations. The mechanical adaptations are not difficult, but the chief obstacle to broader use is the lack of standardization in aircraft design. There is no reason why these rubber bag methods should not find extensive use in airplane subassemblies, when and if some standardization becomes well established. Whether the processes will be adapted to large units, like fuselage halves or complete planes is a problem that time and experience will reveal. The excellent strength/weight ratios of plywood and the smooth rivetless exteriors both add to the air effectiveness of such types of planes.

The resin adhesives are admirably adapted to these molded plane designs. If sufficient heat and pressure are attainable the phenolic liquid resins are preferable,

while the urea resins will give good results if conditions are unfavorable for the use of phenolics.

High-frequency electrostatic methods

The conventional method for manufacturing aircraft plywood with synthetic resin adhesives has been the use of a steam-heated platen in a hydraulic press. While entirely satisfactory on thin plywood, a definite limit in thicknesses appeared when time of heat penetration became excessive and the temperature gradient required to polymerize the resin in the central layers caused an overdrying of the outside layers.

This problem is well on its way toward solution by the utilization of high-frequency electrostatic fields. The material to be heated is placed between the electrodes and experience indicates that suitable temperatures for resin cures can be obtained very quickly, even in the center of a block several inches thick. As a matter of fact, the temperatures attained by the wood are less than those that occur in the adhesive material. This process shortens the bonding time to such an extent that the wood layers suffer little loss of moisture content. It is of course necessary to obtain the required specific pressures by mechanical means that are properly insulated.

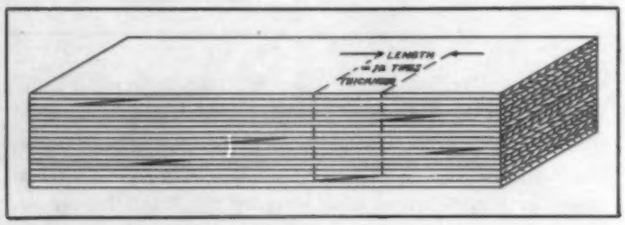
This process is admirably adapted to such thick assemblies as the propeller blanks, described later (25, 41), where heat penetration by the conventional method would be impossible. Whether it will be economical for thin plywood remains to be determined. It is also well suited to cure resin bonds expeditiously in wood and plywood subassemblies on jigs or even in various types of rubber bag assembly processes, heretofore described.

Wood and plywood constructions

There are fundamental differences in design requirements between wood and metal in aircraft construction. Wood has bulk and stiffness with high strength/weight ratios. Wood surfaces can be glued together. These facts give substance to the belief that molded plywood parts, with light but strong arch effects, will be important factors in the aircraft of the future. Metal parts may be thinner and smaller for a given strength, but their attachment methods, by welding and riveting, are much more localized than the gluing together of wood parts over substantial areas. Obviously, the mere substitution of plywood for sheet metal, or vice versa, without fundamental design changes, may lead to serious difficulties. Maximum advantages for each material are only obtainable by intelligent utilization of wood experience on its designs and of metal knowledge on metal constructions.

(*a*) *Laminated spars.* The term laminated refers to the parallel grains of the adjacent layers, while regular plywood has alternately crossed grains. A solid single piece of wood, of same size and species, is less desirable for aircraft work than a laminated piece of the same dimensions, since the fabrication permits balancing or bracing grain effects, reinforcement of adjacent layers, freedom from checking and more uniform moisture content. While spars for small "cub" planes are often solid wood, there is a distinct tendency to make them of laminated layers of sawn or sliced veneer. In general these spars are approximately 1 by 6 in. at the large end, tapered toward the small end, and in solid lumber seldom are available over 20 ft. long. If laminated from $^1/_8$ in. spruce, the lengths can be increased to almost any desired point by staggering and scarfing the splices as shown in Fig. 5. With a properly applied resin adhesive the quality of the laminate will be superior to solid spruce and the cost not out of line.

In larger types of trainer planes spars may either be made of overlaid $^1/_2$ in. layers of solid wood or by aggregating pieces of laminated construction as shown in Fig. 5. These large spars are often built up to 3 in. to 4 in. thickness at the fuselage ends, for reinforcing, while the layers taper or leaf out toward the outer ends. Some spars are made of hollow beam construction toward the outer end, with thin diagonal plywood covering. Urea resin adhesives are suitable for all spar joints, while phenolic resins are preferable in the plywood used for covering.



5—Laminated spars of Sitka spruce veneers: Individual layers are scarfed (L = 12T) to utilize shorter sheets of veneer, also that scarfs are staggered for strength distribution

(*b*) *Plywood ribs and gussets.* There is a wide range of constructions and designs possible here (9). It should be kept in mind that, under column types of loading, solid wood often has a favorable strength/weight ratio over plywood, while for distributed strength and non-splitting qualities plywood is far superior to solid wood. As in the case of the spar constructions, urea resins are best for assembly joints, while phenolic resins are to be preferred for joints in the plywood. In the case of such small areas as are involved in rib assemblies, sufficient pressure is often attainable by properly designed nails, with or without nailing strips, and sometimes by strong spring clamps. The important point in construction is to bring surfaces into intimate contact.

(*c*) *Skin coverings of plywood.* One of the fundamental advantages of plywood is its stiffness/weight factor, which can be simply illustrated as follows: Aluminum sheets have a specific gravity of approximately 2.8, while spruce plywood has a corresponding characteristic of .5 to .6. Hence for an equal weight, plywood can be four to five times as thick, or for equal thickness, plywood is corre- (*Please turn to page 82*)

Flammability of plastic sheets and films

by W. A. ZINZOW*

This paper provides a background and describes some of the work leading up to the A.S.T.M. Tentative Method of Test for Flammability of Plastics which appears on page 62. These two items are reprinted here through the courtesy of the American Society for Testing Materials.

THE constantly increasing use of the numerous plastic materials in the form of sheets and films for decorative as well as other uses makes it desirable to have information about the relative flammability or flame resistance of these materials in the sheet or film form. Many organizations have had specifications relative to this property but no generally accepted method for determining this characteristic was available. Because of this situation a subcommittee of A.S.T.M. Committee D-20 in 1938 accepted the task of setting up a test procedure for making such measurements. The work of this group resulted in the preparation of a Tentative Method of Test for Flammability of Plastics.[9] This Tentative Method was adopted by the Society at its annual meeting held in Atlantic City in June, 1940.

Before drawing up the final form for this test procedure rather extensive tests were conducted by various cooperating laboratories. The data collected as the result of this series of tests were the basis for writing the method. These data have been summarized and are presented herewith as the results of that particular committee activity.

A survey of methods used for measuring the flammability of plastics shows a rather wide variation of procedures. The motion picture industry uses a method for evaluating the burning properties of films.[1] The National Bureau of Standards uses a vertical burning test for testing flame-proofed fabrics.[2] The Underwriters' Laboratories have a flammability test. Other methods are the Freeman Stove Pipe Test,[3] Whipple-Fay Burning Test,[4] British Standards Institution Test,[5] Bell Laboratories,[6] German V.D.E.,[7] and A.S.T.M.[8] In addition to the above methods for evaluating these properties of plastics undoubtedly there are many unpublished specifications set up by many consumer organizations, each of which probably differs slightly from the others.

An analysis of the methods referred to above showed that two of the above methods, with minor modifications, seemed to show the most promise as a method to be used for sheet and film materials. These were the National Bureau of Standards' and Bell Laboratories' methods. The two methods were then modified to permit the use of the same type of specimen, viz., strips 1 in. by 12½ in. by the thickness of the material. The principal point of difference was the method of ignition. The Bell method uses a one inch square piece of cellulose nitrate film affixed to the lower end of the test strip as a fusee material. The National Bureau of Standards' method calls for ignition by means of a carefully defined gas flame. In both methods the specimen is supported vertically in a shield, not the same size, to protect the specimen during tests from casual room drafts. The fusee material in the Bell Laboratories' method is ignited by a match. The gas flame is applied for 12 seconds in the N.B.S. method.

TABLE I. COMPARATIVE RATE OF BURNING BY THE BELL LABORATORIES METHOD

Plastic	Thickness, In.	Inches Burned (Average)	Seconds Elapsed (Average)	Inches per Second
Cellulose acetate M2065-DH	0.005	5.3	8.3	0.64
" " M2065-DH	0.010	1.9	8.3	0.23
" " M2065-DG	0.020	1.6	13.8	0.12
" " M2065-DG	0.030	0.4	8.2	0.05
" " M2065-DG	0.060	0.25	5.0	0.05

The test specimens were distributed to four cooperating laboratories where the materials were tested by both methods as outlined. The laboratories reported both the area of material burned as well as the total time of burning. Comments made by members of cooperating laboratories conducting the test indicated a general preference for the Bell Laboratories' method of ignition, largely for two reasons: (1) the test strip tends to curl up and blow away from the gas flame in the N.B.S. test method; (2) melting material may drop off the test strip and drop on the burner, changing the nature of the flame. Other comments included the following: drafts in room may affect results; stretching of the heated film, which may be slow-burning, does not permit accurate measurement of amount of material burned; material melts, drops off, and continues to burn; test is either too severe or not severe enough to differentiate between materials.

An examination of the data showed reasonably good agreement among four laboratories using equipment and technique which were not identical. This agreement was more noticeable in the case of the Bell Laboratories' method than in the N.B.S. method. A comparison of the amount of material burned with the thick-

* Chief Physicist, Bakelite Corp.

[1] Jour. Soc. Motion Picture Eng., 121, Dec. 1938.
[2] Bur. of Standard Letter Circular No. 467.
[3,4] Trans. Am. Soc. Mech. Eng., 27, 71 (1906).
[5] British Standards Spec. (476, 1932) (738, 1937).
[6] Bell Laboratories Specification: "Inflammability of Cellulose Acetate Sheet."
[7] "Specifications for the Determination of the Char Resistance of Insulating Materials," V.D.E. 0305/1932.
[8] A.S.T.M. D 229-39—"Methods of Testing Sheet and Plate Materials Used in Electrical Insulation."

TABLE II.—Second Series of Flammability Tests

Material	Thickness In.	Lab. A Av.	Lab. A Range	Lab. B Av.	Lab. B Range	Lab. C Av.	Lab. C Range	Lab. D Av.	Lab. D Range	Lab. E Av.	Lab. E Range
Burning Time in Seconds											
Cellulose acetate	.010	7.0	5.2–11.8	6.58	4.75–9.0	5.7	4.6–7.2	5.6	4.9–6.5	6.2	4.8–7.5
" "	.020	6.5	6.0–7.2	8.13	7.0–11.0	7.9	7.4–9.4	9.9	7.4–18.1	7.47	6.8–8.2
" "	.010	17.2	15.4–18.2	18.73	17.5–22.0	14.0	13.0–17.0	14.3	8.6–19.0	22.97	19.4–29.6
" nitrate	.010	4.7	4.0–6.2	4.96	4.5–5.75	3.7	3.4–4.0	7.6	7.0–8.5	5.41	4.6–6.0
" "	.020	6.3	5.6–7.0	6.66	6.0–7.0	5.4	5.2–6.4	9.2	7.6–11.4	6.86	6.2–7.6
" acetate	.060	10.9	9.6–13.6	20.3	18.5–21.5	18.7	17.2–34.6	20.0	19.0–21.3	36.1	14.6–61.5
" "	.060	13.3	11.8–14.6	10.3	9.5–11.0	9.6	9.1–10.4	18.4	14.5–31.9	11.6	10.8–12.9
Vinyl butyral	.020	43.1	42.0–44.8	70.6	65–78	41.9	40.4–45.4	63.1	51.3–71.2	60.3	62.2–75.6
" chloride-acetate	.012	4.5	4.0–5.2	4.83	3.5–7.0	4.9	3.8–7.4	6.3	6.0–6.7	6.1	4.5–7.6
" " "	.020	5.9	5.6–8.2	5.63	4.0–8.0	4.8	3.8–5.8	5.9	5.3–6.5	6.43	5.4–7.0
" " "	.030	6.2	4.8–7.8	5.58	5.0–6.0	5.1	3.8–6.0	6.4	5.3–7.1	4.46	4.1–5.2
Length of Material Burned											
Cellulose acetate	.010	1.6	1.0–2.8	1.9	0.5–32.5	3.9	1.75–5.0	1.9	1.25–2.25		1.00–3.75
" "	.020	0.2	0–1.0	1.04	0.5–2.0	2.6	2.0–3.25	1.3	0.5–3.0		0.25–2.75
" "	.010	12		12		12		10.1	6.25–12	12	
" nitrate	.010	12		12		12		12		12	
" "	.020	12		12		12		12		12	
" acetate	.060	0		0.9	0.5–1.0	2.6	2.5–5.5	1.0			0.00–5.25
" "	.060	12		12		12		12		12	
Vinyl butyral	.020	12		12		12		12		12	
" chloride-acetate	.012	0.5	0–0.8	0		1.5	1.0–2.25	0.3			0.125–3.0
" " "	.020	0.3	0.3–0.5	0		0.5	0.25–0.75	0.1			0.125–1.5
" " "	.030	0.0	0–0	0		0.0	0.0–0.25	0.4	0.25–0.5		0.125–1.8

ness of the stock used showed a relation between the two, in that the rate of burning is roughly inversely proportional to the thickness. Table I shows a comparison made in one of the laboratories.

In consequence of the results obtained on the above tests the group investigating the method decided to write up the procedure to cover points not entirely clear in the first group of tests. Five laboratories cooperated in making this second series of tests using a modified Bell Laboratories test procedure. Table II shows the results obtained in this group of tests. The table shows the average amount of material burned as well as the range for this quantity of the material obtained by each of the laboratories.

An examination of these data indicates that the results from five laboratories check reasonably well as far as burning time is concerned with the exception of some of the slower burning materials. For example, the No. 6 material is somewhat out of line, but the results indicate that this material is not appreciably consumed in the test. It is a very slow burning material that supports combustion for a rather (*Please turn to page 94*)

TABLE III.—Third Series of Flammability Tests

Material	Thickness In.	Lab. A Time Sec.	Lab. A Area Sq. In.	Lab. C Time	Lab. C Area	Lab. D Time	Lab. D Area	Lab. E Time	Lab. E Area	Lab. F Time	Lab. F Area
(1) Proposed Method: Fusee Ignition—Enclosed Shield											
Vinyl chloride-acetate	.012	4.5	0.22	3.5	0	3.3	0.25	3.7	0.63	3.6	0.6
" " "	.030	5.4	0.25	6.2	0	4.9	0	5.1	0	4.75	0
" butyral	.020	54.9	12	41.9	12	70	12	67.6	12	55.8	12
Cellulose nitrate	.010	4.4	12	4.3	12	5.7	12	5.2	12	5.2	12
" "	.030	8.2	12	7.8	12	14.6	12	9.9	12	8.1	12
" acetate	.010	7.6	1.85	4.9	1.33	5.6	1.5	5.6	1.5	6.73	1.43
" "	.030	6.5	0.13	6.2	0	6.1	0	10.9	0.5	5.37	0
" "	.025	40.6	12	34	12	51	12	54.0	12	41.7	2
(2) Proposed Method: Fusee Ignition—Open Front Shield											
Vinyl chloride-acetate	.012	4.6	0.5	4.6	0	4.2	0.25	3.8	0.5	3.36	0.46
" " "	.030	5.2	0.13	6.6	0	4.7	0	5.1	0.1	4.2	0
" butyral	.020	80	12	70.0	12	91	12			81.25	12
Cellulose nitrate	.010	5.1	12	4.9	12	6.6	12	5.4	12	5.05	12
" "	.030	8.5	12	9.0	12	15.4	12	9.5	12	10.0	12
Cellulose acetate	.010	6.5		12.2	2.5	5.6	1.5	8.1	2.4	14.1	2.96
" "	.030	7.4	0.8	7.1	0	9.0	0.25	14.3	1.0	8.36	0.21
" "	.025	50.8	12	48.7	12	88	12.0			49.4	12.0
(3) Benzol Drop Method of Ignition—Enclosed Shield											
Vinyl chloride-acetate	.012	4.4	0	4.7	0	6.0	0	3.5	0.25	3.76	0
" " "	.030	5.6	0	6.2	0	5.3	0	4.9	0	4.2	0
" butyral	.020	94.4	12	46.6	12	77	12	70.6	12	51.2	12
Cellulose nitrate	.010	5.4	12	4.5	12	6.2	12	5.3	12	4.75	12
" "	.030	9.1	12	7.5	12	15.4	12	9.8	12	9.64	12
Cellulose acetate	.010	7.3	0.63	4.7	0.7	4.5	0.25	4.1	0.8	3.76	0.24
" "	.030	11.9	0.17	6.8	0	7.9	0	8.3	0.3	4.7	0
" "	.025	61.8	12	37.4	12	66	12	53	12	36.0	9.04

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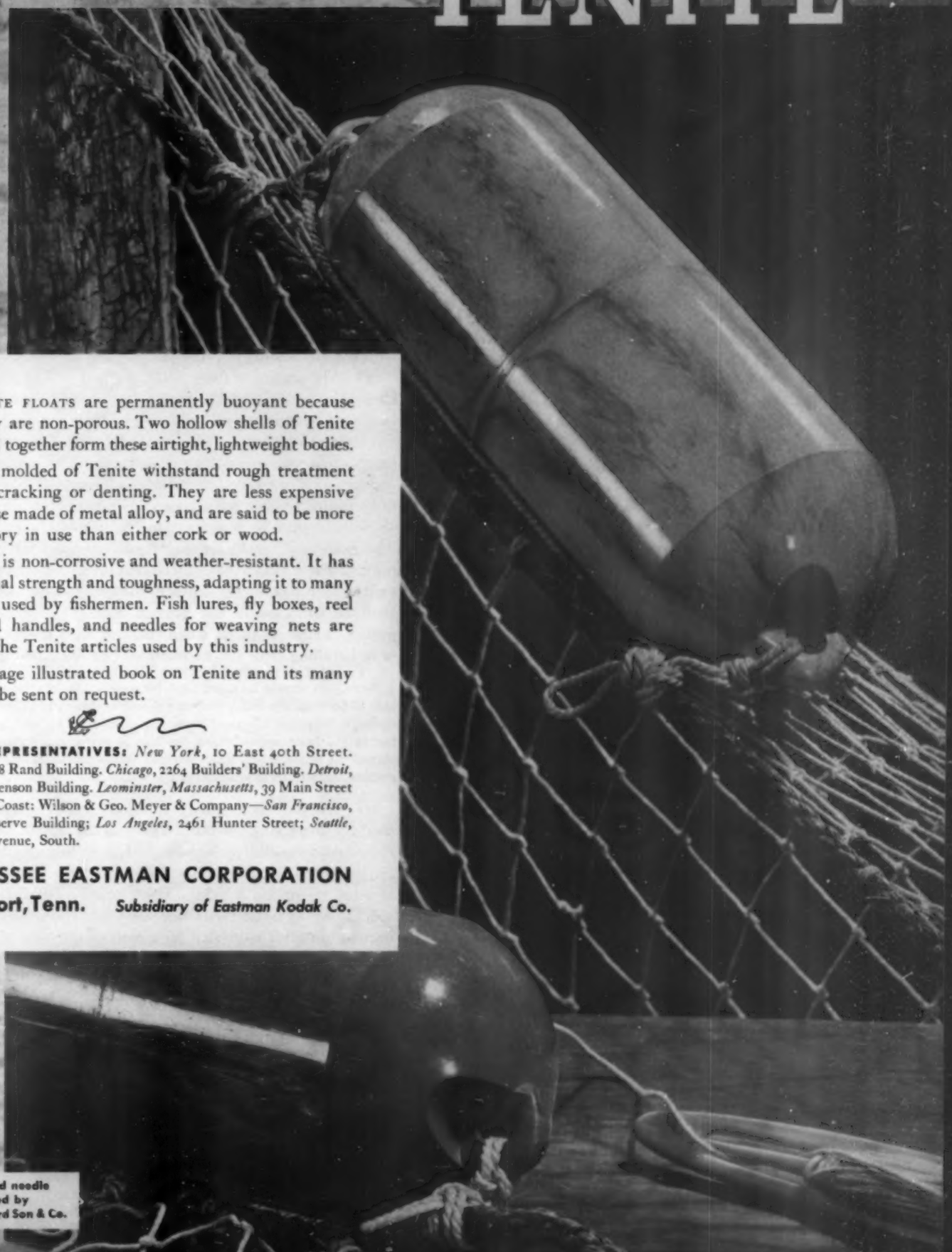

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A.S.T.M. flammability test

THE complete text of the Tentative Method of Test for "Flammability of Plastics," D 568 – 40 T, adopted by the American Society for Testing Materials at its 1940 annual meeting, is published here by permission of the Society.

Scope

1. This method of test is intended primarily for determining the flammability of plastics in the form of thin sheets or films. It is not designed for determining the rate of burning of molded or laminated materials in thicknesses greater than 0.050 in.

Apparatus

2. The apparatus shall consist of the following:

(*a*) *Shield.*—A shield constructed from sheet metal or other fire-resistant material, 12 in. in width, 12 in. in depth, and 30 in. in height, and open at the top. The shield shall be so constructed as to provide a ventilating opening approximately 1 in. in height around the bottom and shall have a viewing window in one side, of sufficient size and in such a position that the entire length of the specimen under test may be observed. Because of danger due to breaking glass, it may be necessary to use heat-resistant glass for the viewing window. One side of the shield shall be hinged (or some other suitable form of construction used) so that the shield may be readily opened and closed to facilitate the mounting and ignition of the test specimen.

(*b*) *Clamp.*—A spring type of paper clamp for holding the test specimen in position. The holding clamp shall be attached rigidly to the shield in such a manner that when the specimen is clamped therein it is centered within the shield facing the viewing window.

(*c*) *Fusee.*—A pyroxylin plastic fusee material 0.010 ± 0.001 in. in thickness. The fusee material shall be made from pyroxylin having a nitrogen content of 11 ± 0.10 percent and containing 25 percent camphor. This material shall be cut into 1-in. squares for purpose of tests.

Test Specimens

3. (*a*) Not less than six test specimens 1 in. in width by 12½ in. in length shall be cut from sheets of each of the materials being tested. The thickness of the specimens shall be determined in accordance with the Tentative Methods of Test for Thickness of Solid Electrical Insulation (A.S.T.M. Designation: D 374) of the American Society for Testing Materials.[1]

(*b*) The test specimen shall be marked into squares ½ in. on a side before the test is started. This marking may be done by any convenient means, provided the markings are still visible on the unburned portion of the specimen after the test is completed.

[1] 1939 Book of A.S.T.M. Standards, Part III, p. 707.

Procedure

4. (*a*) The 1-in. square piece of fusee material shall be affixed by means of acetone to one end of the test specimen, with an overlap of ¼ in. In some cases it may be necessary to dry under slight pressure or to use a stapling device to fasten the fusee to the test specimen. After drying for 2 hrs., exposed to the air at 25 ± 3 deg. C., the specimen shall be hung vertically by means of the supporting clamp, in approximately the center of the shield. The fusee shall be at the lower end of the test specimen. The specimen shall be clamped in such a manner that 12 in. of it is exposed below the clamp. The shield shall be placed in a hood, with the ventilating fan turned off at the time of test.

(*b*) The square of fusee material shall be ignited by means of a safety match, and the door of the shield shall be closed immediately (Note). The time required for the flame to either extinguish itself or to completely burn the test specimen shall be determined by means of a stop watch or timer, started at the instant of ignition of the fusee. The area of the specimen that is burned or charred shall be measured to the nearest ¼ sq. in. The markings on the specimen may be used for estimating the amount of material burned. If material melts and drops from the specimen, the area melted shall be included in the burned area. The charred portion which drops off when touched with the fingers or in handling shall also be included in the burned area.

NOTE.—It should be noted that for some materials the products of burning are toxic, and care should be taken to guard the operator from the effects of these toxic gases. The ventilating fan in the hood under which the test is performed should be turned on immediately after the test is completed in order to remove any irritating products of the test.

(*c*) Another convenient method, which may be used for measuring the burned area in the case of materials that do not stretch under test, is to use a scale 12 in. in length by 1 in. in width ruled with lines into squares ½ in. on a side. The partially burned test specimen may be laid over this scale, and the amount of burned material estimated by means of the area of the scale left exposed.

Report

5. The report shall include the following:

(*1*) Thickness of the material,

(*2*) Length of time in seconds that the material continues to burn, and

(*3*) Area in square inches of the burned portion of the test specimen.

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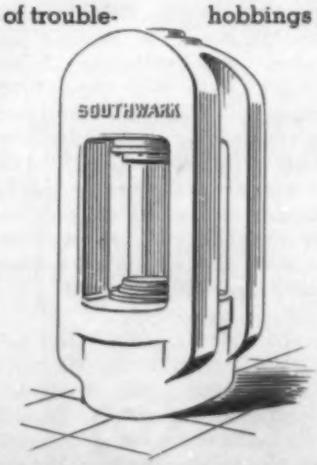

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Plastics digest

This digest includes each month the more important articles (wherever published) which are of interest to those who make plastics materials or use them. Requests for periodicals mentioned should be directed to the individual publishers.

General

PLASTICS IN 1940. Chem. and Met. Eng. *48*, 98–100 (Feb. 1941). Phenolic, urea, cellulose acetate and acetate butyrate, vinyl, and acrylic plastics made large gains in 1940. Vinylidene chloride and melamine resins are newcomers that show great promise of becoming important members of the plastics group. Production in pounds of various plastics during 1940 is estimated as follows: cellulose acetate 24,000,000, of which 15,000,000 was in molding compound and the remainder in sheets, rods, and tubes; cellulose nitrate 11,800,000; polyvinyl butyral 5,000,000; polystyrene 1,500,000; urea-formaldehyde 18,000,000, of which 11,000,000 was in molding compound, 1,000,000 in laminating, 4,000,000 in adhesives, and up to 2,000,000 in textiles and other applications; acrylic 3,000,000; phenol-formaldehyde 59,000,000, of which 41,000,000 was used in molding compound, 10,000,000 in laminating, and the remainder in protective coatings and other applications; and cast phenolics 6,600,000.

PLASTIC MOLDING COMPOSITION MADE FROM BRAZILIAN COFFEE. Oil, Paint, and Drug Reporter *139*, 3, 44 (Feb. 3, 1941). Caffelite is a thermosetting molding compound which is cured at 325–350 deg. F. under pressures ranging from 2500 to 5000 lbs. per sq. in. Three producing units are planned by the Caffelite Corp. in an arrangement reported to have been consummated with the Brazilian government. The first will handle 50,000 bags of coffee beans annually (about 6,500,000 lbs.), and is about ready to go into production. The second, now two-thirds completed, will handle 1000 bags per day. The third unit, scheduled for completion next year, will have a processing capacity of 5,000,000 bags annually. Regarding supplies of raw material, over 70,000,000 bags of coffee beans have been destroyed by Brazil in the last ten years. Among other products which it is planned to produce from the coffee bean are caffeine, alpha-cellulose, furfural, and a coffee oil useful in soaps, polishes, and insecticides.

ALGINIC ACID—A NEW RAW MATERIAL FOR RAYON MANUFACTURE. W. F. P. Wilsome. Textile Colorist *63*, 83–4 (Feb. 1941). A review of Speakman's work on the conversion of alginic acid obtained from seaweed into fibers.

Materials and Manufacture

PLIOLITE-RUBBER MIXTURES. H. R. Thies. Ind. and Eng. Chem. *33*, 389–93 (Mar. 1941). When rubber is cyclized with halides of amphoteric metals, such as tin tetrachloride and chlorstannic acid, "Pliolite" resins varying in physical properties from rubbery to hard shellac-like characteristics are obtained. There is a change in the unsaturation, but no change in composition. Their use as molding materials was described in Ind. and Eng. Chem. *26*, 123 (1934) and in U. S. P. 1,751,817. The properties of products prepared by compounding Pliolite with synthetic and natural rubbers are set forth in this paper.

ZEIN—A NEW INDUSTRIAL PROTEIN. L. C. Swallen. Ind. and Eng. Chem. *33*, 394–8 (Mar. 1941). Zein is an alcohol-soluble protein, obtained as a by-product in corn processing, which can be used in making plastics, paper coatings, adhesives, laminated boards, films, and the like. It is compatible with highly acidic and alcohol-soluble resins, such as rosin, shellac, and manila gum, and relatively neutral ester gum. Products of improved toughness, mechanical strength, and water resistance are produced by reaction with formaldehyde in the presence of acid catalysts. Solvents and plasticizers for zein are those types which have free hydroxyl, carboxyl, ketone, amino, or amide groups. Usually addition of water or secondary solvent is required.

INVESTIGATIONS OF PHENOPLASTS. H. Stäger, W. Siegfried, and R. Sänger. Kunststofftagung (Zurich, Switzerland), pages 5–43 (Aug. 1940). This report is divided into three parts dealing, respectively, with (1) the structural units of phenolic resins, (2) the dependence of strength properties (impact and flexural) on chemical structure, and (3) the same for electrical properties. Profuse use is made of microphotographs and graphical presentation of data.

MEASUREMENT OF THE MECHANICAL PROPERTIES OF SYNTHETIC RESINS. G. O. Grimm. Kunststofftagung, pages 44–53. Development of a tensile test specimen and tensile strength data for phenolic, urea, and melamine resins with various fillers are reported. Microphotographs show unusual physical structures of some of the test specimens. Discussion of this and the preceding reference is on pages 54–65.

Molding and Fabricating

MOLDING WITHOUT MOLDS. Plastics *5*, 15–6 (Jan. 1941). A shot-molding process developed by the British Thomson-Houston Co., Ltd., is described. The object wrapped with resin-impregnated strips and protected by a rubber bag or sheet is placed in a strong molding box and is surrounded with hot steel shot. The top of the box is closed with a thick steel plate which in effect becomes the plunger which transmits the pressure from a hydraulic press to the shot. This plunger needs to fit only sufficiently close to prevent the passage of the .040-in. shot.

CONTROL CIRCUITS FOR INDUSTRY. G. Smiley. Electronics *14*, 29–33 (Jan. 1941). Application of the gas tetrode, type 2050 or 2051, for automatic control of injection molding operations is discussed and the circuit diagrammed.

Applications

PLASTICS IN AIRCRAFT CONSTRUCTION. W. H. Francis. Aero Digest *38*, 238, 242, 272 (Mar. 1941). The future success for adapting plastic and plywood materials to the airplane structure is dependent upon a thorough standardization of material procurement specifications and test methods. The physical data which are available for metallic aircraft materials in common usage and are listed in Strength of Aircraft Elements ANC-5, should be determined with particular regard to the possible variations in these properties over the temperature range −40 deg. to +160 deg. F.

PLASTICS FOR DOMESTIC USES. P. Grodzinski. Plastics *5*, 26–8 (Feb. 1941). Experiences of German engineers in using plastics in place of metals are recorded. The parts considered specifically are radiator valves, gas cocks, and floats and valves for lavatory tanks.

PLASTICS IN WEARING APPAREL. H. S. Bunn. Ind. and Eng. Chem. News Ed. *19*, 135–9 (Feb. 10, 1941). Four major types of plastics are used in wearing apparel. Rigid thermosetting materials are used in buttons, jewelry, and bag frames. Rigid thermoplastics are employed in shoe-heel covers, slide fasteners, and dress accessories. Flexible, elastic thermoplastics are made into raincoats, men's belts and suspenders, and women's hats, dress trimmings, and shoes. Synthetic fibers are prepared from plastics, such as Lanital, soybean protein, nylon, and Vinyon.

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Maas and Waldstein's special finishes for phenolic and certain other plastics help solve a serious problem for manufacturers switching to plastics because of metal shortages due to national defense requirements.

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PLASTICIZER. A. Hill (to Imperial Chemical Industries, Ltd.). U. S. 2,230,351, Feb. 4. Reacting castor oil with a polycarboxylic acid and chlorinating the product to form a flame-resistant plasticizer.

SIZING TEXTILES. M. W. Mason (to Pittsburgh Plate Glass Co.). U. S. 2,230,358, Feb. 4. Laundryfast sizing of fabrics with a vinyl chloride:vinyl acetate interpolymer plasticized with diamyl phthalate.

AIRPLANE STRUCTURAL ELEMENT. J. Thompson. U. S. 2,230,393, Feb. 4. In an aircraft structure an assembly of spar and wing sections of plastic materials with various abutting relationships of flanges of the spar and ribs of the wing section.

ION EXCHANGE RESIN. D. M. Findlay (to U. S. Rubber Co.). U. S. 2,230,641, Feb. 4. Purifying water by contact with a phenolsulphonic-acid-formaldehyde resin.

PRINTING PLATE. C. Heuck and A. Freytag (to I. G. Farb. Akt.). U. S. 2,230,776, Feb. 4. Making printing plates from a styrene:acrylonitrile or styrene:methacrylonitrile resin.

PRINTING PLATE. W. Reppe and A. Freytag (to I. G. Farb. Akt.). U. S. 2,230,784, Feb. 4. Methyl methacrylate printing plates.

SLIDE FASTENERS. G. Sundback (to Talon, Inc.). U. S. 2,230,785, Feb. 4. Apparatus for molding slide fastener stringers from a plastic.

PHENOL RECOVERY. M. Pier, W. Simon and G. Grassl (to General Aniline and Film Corp.). U. S. 2,230,812, Feb. 4. Pressure extraction of phenol-aldehyde resins with a hydrocarbon solvent to recover phenol.

ELECTRIC CABLE. W. F. Lamela (to Okonite Co.). U. S. 2,230,887-8, Feb. 4. A cable in which individual conductors are protected by asbestos roving with a flameproof binder has a winding of tape filled with polyvinyl halide, and a final wrapper of polyvinyl halide.

WATERPROOF SANDPAPER. R. P. Carlton and B. J. Oakes (to Minnesota Mining & Mfg. Co.). U. S. 2,230,934, Feb. 4. Bonding abrasive grains to a paper backing with an oil-reactive phenolic resin, flexibilized with an alkyd resin.

ORIFICE PLATE. Wm. R. Law. U. S. 2,230,959, Feb. 4. An orifice meter plate for use in pipelines carrying corrosive or abrasive liquids is made of fabric impregnated with a phenolic resin.

BOBBIN HEAD. H. W. Mack (to Allentown Bobbin Works, Inc.). U. S. 2,230,964, Feb. 4. A laminated bobbin head has alternate paper and fabric layers impregnated with a synthetic resin.

PRINTING PLATES. Wm. C. Toland and E. Bassist (to Wm. C. Toland). U. S. 2,230,981-2, Feb. 4. A printing plate with water-receptive areas of polyvinyl alcohol; and planographic plates having a base coated with a hydrophilic resin on which selective grease-receptive printing layers are formed.

EYECUP. B. F. Conner (to Colt's Patent Fire Arms Mfg. Co.). U. S. 2,231,112, Feb. 11. A molded eyecup having bowl and base sections held in position by interengaging portions.

MOLDING MACHINE FEED. J. A. Muller, W. R. Tucker and G. M. Geiger (to Hydraulic Press Corp.). U. S. 2,231,281, Feb. 11. An adjusting screw for coupling two movable members of a mold feed device.

DRY CELL. C. F. Burgess (to Burgess Battery Co.). U. S. 2,231,319, Feb. 11. A zinc electrode for dry cells is coated with polyvinyl acetate.

RESIN COATING. W. W. Castor and F. R. Stoner, Jr. (to Stoner-Mudge, Inc.). U. S. 2,231,407, Feb. 11. Protecting metals by a baked film having a vinyl chloride : ethyl acrylate interpolymer resin at the air interface and a modified alkyd resin at the metal interface.

TRANSPARENT PLASTICS. A. P. Anderson (to Shell Development Co.). U. S. 2,231,419, Feb. 11. Hydrogenating an albino asphalt to form a new transparent petroleum plastic.

SAFETY GLASS. R. Hill (to Imperial Chemical Industries, Ltd.). U. S. 2,231,471, Feb. 11. An interpolymer of methyl methacrylate and another methacrylate as interlayer in safety glass.

ELECTRIC INSULATION. M. M. Safford, R. C. Feagin and B. W. Nordlander (to General Electric Co.). U. S. 2,231,595, Feb. 11. Insulation with low power and loss factors is made of gamma-polyvinyl chloride, tricresyl phosphate and lead phenolate.

ELASTOMERS. B. J. Habgood, R. Hill, E. Isaacs and L. B. Morgan (to Imperial Chemical Industries, Ltd.). U. S. 2,231,623, Feb. 11. Emulsion interpolymerization of butadiene or isoprene with a beta-(2-furyl)acrylate ester to form a rubber-like product.

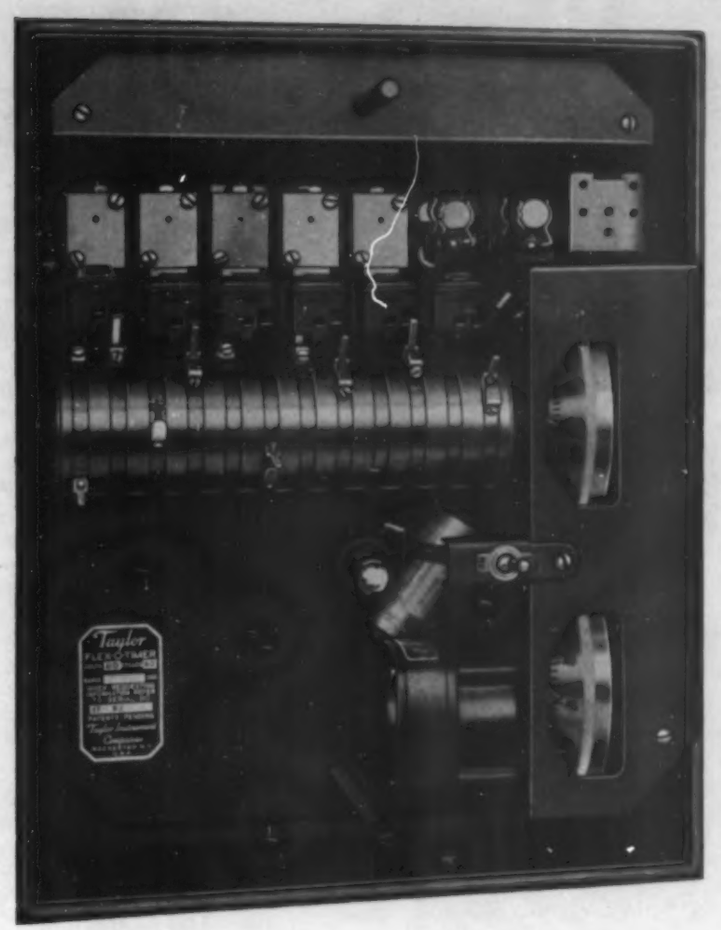
OIL-SOLUBLE RESIN. W. Wolff (to General Aniline & Film Corp.). U. S. 2,231,649, Feb. 11. Acid polymerization of vinyl abietinyl or vinyl hydroabietinyl ether to form a varnish resin.

MATRIX. E. O. Norris (to Edward O. Norris, Inc.). U. S. 2,231,678, Feb. 11. A nickel sheet with Bakelite-filled depressions is joined to a shellac-coated copper sheet and a film of metal is electrodeposited on the exposed metal surrounding the depressions, to form a perforated sheet which is then stripped from its base.

PLASTICIZER. L. W. A. Meyer (to Eastman Kodak Co.). U. S. 2,231,729, Feb. 11. Plasticizing cellulose acetate with a dilactate of a glycol, higher than ethyleneglycol but not higher than hexanediol.

PLASTICIZER FOR ACETAL RESIN. J. B. Normington and Fred C. Duennebier (to Eastman Kodak Co.). U. S. 2,231,733, Feb. 11. Plasticizing polyvinyl acetal resins with a short chain alkoxybenzoate of a cyclic alcohol or of ethyleneglycol, diethyleneglycol or one of their ethers.

THIS IS IT



(Shown left) Interior of Taylor Flex-O-Timer, showing 8 latch operators, 7 air valves and 2 mercury switches.

This is the Taylor Flex-O-Timer

YOU NEED IT...

This instrument is proving to be one of the most efficient time cycle controllers yet developed for Industry.

With the Taylor Flex-O-Timer, you can automatically synchronize processing operations so exactly that your press men's job narrows down to merely loading and unloading the presses. Everything else is automatic. Human variations in timing can't throw the processes out of step. And you'd be surprised how its use can step up production!

This Taylor Flex-O-Timer times precisely the sequence and duration of temperature, pressure, and humidity operations, or their combinations. It guarantees uniform results because it insures uniform processing.

Here's the *adaptable* timer that fits itself to your new or changing process requirements—fits the job instead of trying to make the job fit it. It is furnished with any one of 11 adjustable time ranges, each of which provides 78 different cycles by means of a finger-tip adjustment.

This Taylor Flex-O-Timer starts processes instantaneously—snap-acting operators work simultaneously with the starting of the motor.

The air valve is 99½% efficient in utilizing the air passing through it—its large capacity simplifies piping because you often don't need auxiliary pilot valves.

No cam cutting, either, with the Taylor Flex-O-Timer. Adjustable actuating pins on the one-piece drum are easily and accurately locked in place. You can use it for electric or pneumatic operations, or both.

One example of many merits: with this instrument, together with the Taylor Bumping unit, you can "bump" a press automatically, merely by pushing a starting button. Such automatic "bumping" (or "gassing") on a pressure-time basis is exclusively Taylor's. See *why* you need the new Taylor Flex-O-Timer? Ask the Taylor man. Or write Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada.

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Publications

Write direct to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

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1940 Supplement to A.S.T.M. Standards

Published in 3 Parts by the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa.

Price: $7.00 complete, 2 vols. $5.00, 1 vol. $3.00.

The availability of the 1939 Book of A.S.T.M. Standards was announced in the June 1940 issue of MODERN PLASTICS. To bring the information on A.S.T.M. testing methods up to date, a Supplement to each of the three parts has been issued, containing new and revised standards and tentative standards, and proposed revisions of standards. These Supplements relate, respectively, to the same materials covered in the triennial Book of Standards, namely: Part I, Metals; Part II, Nonmetallic Materials, Constructional; Part III, Nonmetallic Materials, General, including plastics. An Index to A.S.T.M. Standards and Tentative Standards which lists all of the methods appearing in the 1939 Book of A.S.T.M. Standards and the 1940 Supplements is published separately and furnished without additional charge to purchasers of any or all volumes of the 1940 Supplements. G. M. K.

Trade-Names Index

Published by Special Libraries Assn., 31 East 10th St. New York, 1941

Price $4.00 **174 pages**

An aid in identifying and defining numerous products known and sold under "coined" names or trade-names, this volume contains an alphabetical list of 3496 trade-names. For each of these a definition is given and usually a reference to a printed source of further information is cited. In general, the list is concerned with materials, processes and equipment having some technical significance but it is far from complete. There are many discrepancies and inconsistencies in quoted material as well as important omissions, particularly in the plastics field. The volume does include a record of other sources for further lists and information but it is unfortunate that the compilation was not made more carefully and thoroughly since an index such as this could be extremely valuable. H. B. J.

Crosby-Fiske-Forster Handbook of Fire Protection, 9th Edition

by Robert S. Moulton, General Editor

Published by National Fire Protection Association, 60 Batterymarch St., Boston, Mass., 1941

Price $4.50 **1332 pages**

Leading authorities in the fire protection engineering profession assisted in the preparation of the 59 chapters of this reference work. Among the topics considered are problems involved in handling flammable liquids, pyroxylin plastics, and organic finishing materials. The book provides in compact form the essential information on good practice in fire prevention and fire protection, bringing this subject up to date from the last edition in 1936. It is a book that should be studied carefully by every engineer charged with the safety of life and property in his particular plant. G. M. K.

★ TWO NEW PAMPHLETS DESCRIPTIVE OF BARNES power and control panels has recently been issued by John S. Barnes Corp., 301 South Water St., Rockford, Ill.

★ COMPLETE DESCRIPTIONS AND ILLUSTRATIONS of the newly improved patent rotary cutters designed especially for the reduction of plastic materials are contained in a 16-page catalog recently issued by Ball & Jewel, 22 Franklin St., Brooklyn, N. Y. Machines are illustrated with detailed explanations and full specifications are included.

★ *DISSTON TOOL STEELS* IS THE TITLE OF A NEW catalog just issued by Henry Disston & Sons, Inc., Philadelphia. Issuing this book constituted one of the company's activities in observing the 100th anniversary of the Disston business. Besides photos of company executives and candid shots taken of the men at work the book contains several tables of useful information for those interested in buying steels.

★ A BROCHURE ON AMERICAN DESIGNED AND MADE Parkwood products has been issued by the Parkwood Corp., Wakefield, Massachusetts. Descriptions of the various types of domestic and foreign woods are given, as well as illustrations of the jewelry, boxes, trays and cigaret cases now available.

★ A NEW BOOKLET ENTITLED *HERCOLYN AND Abalyn, Liquid Resins of Abietic Acid* has just been issued by Hercules Powder Co., Wilmington, Del. It cites properties and experimental data that indicate the value of these two liquid resins in ethylcellulose and vinyl acetate-chloride plastics, casein compositions, urea-formaldehyde plastics, cold-molded plastics of various types, as a modifier and extender for phenol-formaldehyde plastics, and through condensation or polymerization for the production of special synthetic resins.

The booklet gives data on ester content, specific gravity, acid number, saponification number, color, viscosity, flash point, flame point, vapor pressure, boiling point, thiocyanate value, weight and specific rotation of the resins. Tables and graphs of vapor pressure, thermal stability, and electrical characteristics, and typical emulsion formulations are included.

★ AN 8-PAGE FOLDER ENTITLED *WHAT MATERIAL* has been issued by the Continental Diamond Fibre Co., 6 Chappel St., Newark, Delaware. The folder describes the company's various materials with reference to their peculiar properties that adapt them to specific jobs. Charts and illustrations add to the value of the booklet.

★ A 32-PAGE ILLUSTRATED CATALOG PUBLISHED by The American Rotary Tool Co., Inc., 44 Whitehall St., New York City, is now available. Disks, drills, files, saws and wheels are among the many items listed in the extensive line. A price list is also included.

★ AN OCCUPATIONAL BRIEF ENTITLED "YOU MIGHT like Chemurgy as a Career," has been issued by Western Personnel Service, 30 North Raymond Ave., Pasadena, Calif. One of a series of studies prepared to assist students in planning a career, it is available at 25¢ for single copies and at 15¢ each for 10 or more.

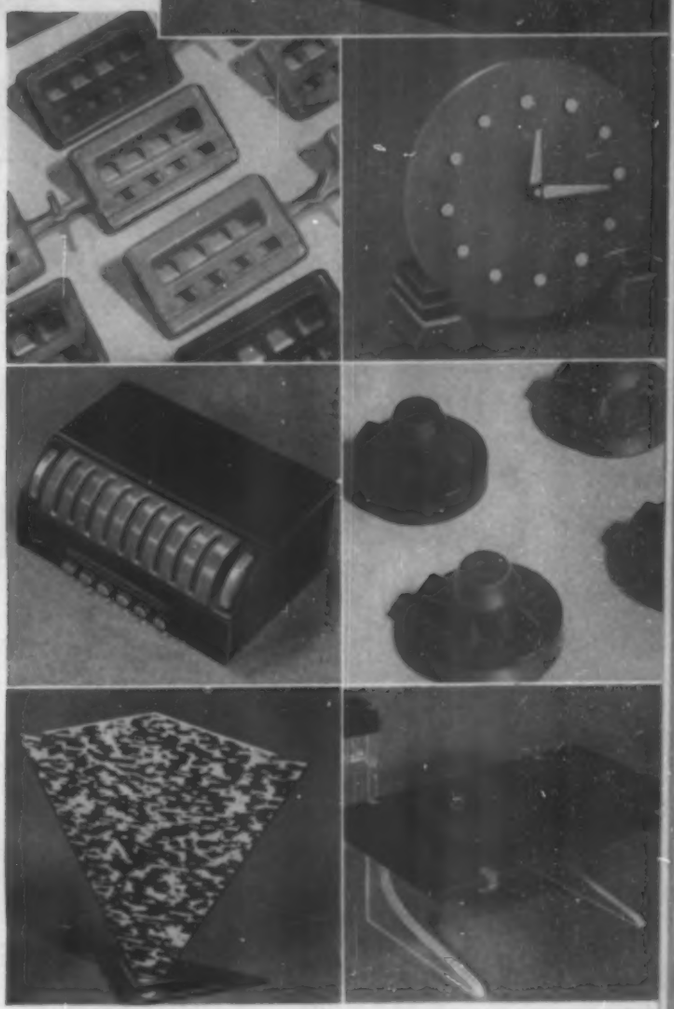
★ *SEMI-CONDUCTING RUBBER AND SYNTHETIC RUBber Compounds*, a 3-page mimeographed reprint of an article by A. E. Juve of its mechanical division technical staff, has been released by B. F. Goodrich Co., Akron, Ohio.

★ A NEW CATALOG (ZB41) OF LABORATORY APPAratus has been published by the American Instrument Co., Silver Spring, Md. The catalog contains 184 pages describing instruments and apparatus for chemical, biological, physical, clinical, pathological, research, engineering and materials testing laboratories. A new section is devoted to laboratory and field instruments used by soil and agricultural chemists and agronomists.

From Drawing Board To Finished Products...

PLASTICS ITI TRAINING
is based upon actual projects

Practical knowledge of plastics and their applications is gained by working on actual projects in Plastics ITI laboratories and shops. Many student projects start with the creation of an original design... selection of materials is part of classroom work... the design is engineered in the drafting room... completed by the most suitable shop method — molding, fabricating, laminating or casting... all on standard equipment... as in plastics plants.



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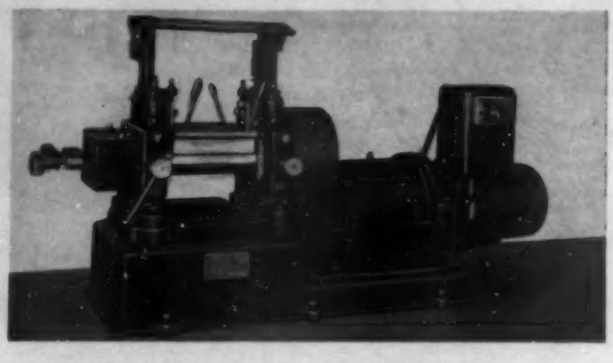
Machinery and equipment

★ WALKER-TURNER CO., INC., ANNOUNCES A NEW low-cost Radial Drill for performing light duty operations. Said to perform such operations as drilling, tapping, routing and light profiling with speed and accuracy, it may be used in the aircraft industry for stack-drilling sheets, spars, etc., by tool makers for drilling in jigs and fixtures and for pattern making; by shipbuilders for drilling metal plates and sheets; in the electrical industry for drilling switchboard panels, etc., and in countless industrial plants for a variety of operations.

The drill head, ram and cradle swing easily right and left on a machined collar mounted on the top of the raising and lowering column. A clamp lock permits locking the drill in position quickly and easily. The drill head ram and cradle are raised and lowered by a crank-operated screw mechanism mounted on the side of the supporting column. A clamp lock is provided here also. Capacity of the drill is unusually large, drilling to the center of a 62 in. circle; ram travel is 18 in.; maximum distance of chuck to table is 13 1/2 in.; vertical movement of drill head is 8 1/2 in. and spindle travel is 3 3/4 in. Capacity of the Jacobs Chuck is 1/2 in. Height overall is 72 in., width 31 in., and depth front to back is 58 in. Shipping weight 450 lbs.

★ LYON HYDRAULIC ELEVATING TABLE (PICTURED above) is operated by a foot pedal and is guided so it cannot swivel on the base. It is handy for moving dies in and out of presses, lifting or supporting overhanging work on various machines, transferring heavy materials or parts, and may be adjusted to various heights for use as a portable work table. Standard size is 24 in. by 30 in., elevated height 42 in., lowered height 28 in., elevation 14 in. Capacity is 2000 pounds.

★ A NUMBER OF NEW WIRING DEVICE ITEMS, including outlets, caps, switches, and sockets, some for special uses on farms, some for temporary decorative lighting, and others for industrial applications, etc., for other outdoor uses have been announced by the appliance and merchandise department of the General Electric Company. The devices include a polarized twin convenience outlet and cap, new weather-proof sockets with a metal enclosure, a new pin-type weather-proof socket and switches and outlets on molded box covers for insulated systems.



★ OWING TO THE DEMAND BY VARIOUS PLASTICS laboratories for the development of a precision-built mixing mill small enough to permit the use of very small quantities of material, Wm. R. Thropp & Sons Co. has introduced a miniature mixing mill with 3 in. diameter rolls and 8 in. face. This mill, shown above, can be placed on a table for operating convenience. It is equipped with hardened polished rolls which are hollow chambered to permit either heating or cooling and may be operated in proportional speeds and temperatures to large production equipment. It contains its own 2 hp. geared head electric motor and solenoid disk brake for safety in operating the rolls. The mixing capacity is from 25 to 100 grams.

★ IDENTIFICATION AND DECORATIVE PLATES ARE often finished or decorated by means of stencils and manually operated or automatic spray guns. DeVilbiss Co. reports that their spray gun equipment is frequently used for finishing or coating plastics as shown above in which an operator is pictured spraying color on all-plastic finger nail shields. Depending entirely upon the size of the product and volume of production, equipment used consists primarily of a spray gun and material container together with the necessary air transformer and hose and worked on in a spray booth. Ordinarily the operation is manual. There are several types of guns and all automatic machines are built to customer specification, the company informs us.

(*Please turn to next page*)

PLASTIC MOLDED HANDLES

Ideal for Portable Radios, Instrument Kits, Sport Bags, Portfolios, Travel Bags, Suit Cases, Gladstones, Brief Cases—these plastic handles supply the necessary touch of color that modern styling demands.

They are smooth, sanitary, pleasing to the touch and fit the hand perfectly. No stitches to rip nor bulging seams to hurt the hand. Will support a weight of 150 pounds. Made in two sizes; one measuring $4^{3}/_{8}$ inches, the other $3^{1}/_{8}$ inches between supports.

Stock colors are Black, Brown, Ivory and Buckskin. Other colors special.

SEND FOR SAMPLES AND PRICES

CHICAGO MOLDED PRODUCTS CORP.

1046 NORTH KOLMAR AVENUE — CHICAGO, ILLINOIS

★ A NEW 10-IN. TILTING ARBOR CIRCULAR SAW has been announced by the Yates-American Machine Co. According to the manufacturer, this saw was developed especially for use in production plants, schools, pattern shops, furniture factories, contractors and other types of operations where full capacity is essential. According to specifications released, it has a standard one-piece table 32 in. by 36 in., which provides for a cut-off capacity of 17 in. ahead of the saw on the table itself—25 in. when front table extensions are used. These extensions, incidentally, are furnished as standard equipment at no extra charge. The saw will rip to the center of 38 in. stock without extensions and to the center of 50 in. stock with side extensions which are offered as extra equipment. Stock $3^1/_4$ in. thick can be cut, it is claimed. It features a hoisting and tilting mechanism, a simple pin-type arbor lock to enable the operator to lock the arbor securely when changing saw blades.

★ AN INGENIOUS ATTACHMENT (ABOVE) HAS BEEN developed by Delta Mfg. Co. for 14 in. drill presses that is said to provide a wide range of speeds for both high and slow speed models. This attachment, quickly removed and easily adjusted, consists of a heavy casting which mounts in the drill press column together with a cone pulley and two belts. Belt slack is taken up turning the casting for proper tension. A range of 12 speeds is available through various combinations. A grease-sealed ball bearing pulley is used in the assembly for smooth, even, vibrationless running.

★ A UNIVERSAL SLOTTING HEAD (ABOVE) USED FOR many types of milling machines for precision work is announced by the Special Machine Div. of the Experimental Tool & Die Co. The stroke of the ram is adjustable from 0 to 4 in. and the adjustment may be quickly and accurately accomplished, it is said. The head is equipped with a $^1/_4$ hp. motor with four speed changes —the speeds range from 50 to 250 or from 100 to 580 strokes per minute. The Tool Holder, of the clapper-box type, can be turned in any position desired. According to the manufacturer, it can be used for cutting keyways, templets, splines, internal gears and for slotting out precision blanking dies or wherever sharp corners and special shapes must be machined.

★ TABER INSTRUMENT CO. HAS INTRODUCED THE Research Model Taber Abraser said to be an efficient and accurate testing machine for evaluating resistance of surface finishes to rubbing abrasion, such as paints, lacquers, electroplated and plastic surfaces and textile fabrics ranging from sheer fabrics to upholstery. The primary elements of the unit (above) are the motor driven turntable on which the specimen is mounted, a counter to indicate the number of abrasion cycles and two abrading wheels that alternately rub back and forth and at the same time criss-cross in their rolling path. These wheels are made in five types of closely controlled resilient material charged with special grades of fine abrasive grain. Supplementing the wear resistance test is the shear-hardness test performed by attachment E-3720 which measures the toughness quality of a plastic surface or its ability to resist digs, scrapes, and similar physical damage not classed as normal wear.

★ TEMPERATURE CONTROL IS SIMPLIFIED, IN that resettings with the new Brabender adjustable electric Thermo-regulator, are now reported possible within a few seconds. An almost instantaneous resetting is made, by simply moving the magnet to the desired temperature position. This thermo-regulator consists of an upper (control) and a lower (mercury) column with a contact bridge located between the two columns. The lower column has exactly the same temperature reading as the upper. Within the inner tube of the Thermo-regulator and movable over the entire temperature range of the upper column, is located a glass-encased iron rod, which is controlled by a magnet. A thin wire of definite length extends from this rod into the lower column over the contact bridge. The mercury, on rising, establishes contact with the thin wire, thus closing the electric circuit. When the temperature drops and the mercury withdraws again from the thin wire, the electric circuit is opened.

NATIONAL RESEARCH CREATES NEW PRODUCTS ★ NEW MARKETS

Electric Current Flows Safely to Ships in Dry Dock

thanks to PHENOLITE in "Ship-to-Shore" connectors

PHENOLITE perfectly provides essential insulation for "ship-to-shore" connectors. Manufactured by Russell & Stoll Company.

WHEN ships are in dry dock or tied up for repairs, "ship-to-shore" connectors carry the electrical current for power and light on board.

These connectors have to be made of a material that will withstand the most vigorous treatment. Housed in heavy bronze enclosures is the heart of these connectors — insulating supports for the contact members, made of Phenolite, laminated Bakelite. A wide variety of housing designs are available to suit individual requirements but the important insulating task in all of them, is assigned to Phenolite. The selection of Phenolite for this particular job is explained by the fact that it resists the corrosive action of harbor gases; weather has no effect on it; it is unbreakable . . . it does not split, splinter or rust . . . and it has exceptional dielectric strength. Phenolite, in short, can "take it."

This use of Phenolite is but one of countless applications where, because of its singular characteristics, it makes unusual products possible. National's technical men are constantly working with engineers in industry on problems where Phenolite or National Vulcanized Fibre may be used advantageously. It may be that our technical research service may be of assistance to *you*. We invite your inquiry.

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These NATIONAL Products have a Cost-Cutting Application in your field. We can make it easy for you to select the right product and grade.

PHENOLITE Laminated BAKELITE

In the limelight

★ DEFENSE WILL BE THE KEYNOTE OF NATIONAL semi-annual spring meeting of The Society of the Plastics Industry at Hotel Homestead, Hot Springs, Virginia, on Monday and Tuesday, May 5th and 6th. A complete report of the activity of the plastics defense committee heads the interesting program which the committee has arranged. Colonel K. F. Adamson of the Ordnance Department of the United States Army who won through his stimulating remarks to the plastics defense conference the enthusiastic respect of those who heard him, has accepted an invitation to address the meeting. Glen Smith of Cleveland, Ohio, nationally known labor authority, will discuss current labor trends. Priorities, plastics replacing metals in automobiles and the available plastics raw material resources are other timely topics, which the committee has scheduled. The regular section and joint meetings of the molders, machinery and material suppliers sections will be held. Election of a Board of Directors and officers for the coming fiscal year is also on the agenda of the meeting. The SPI Board has arranged for a full two day session to permit the complete discussion of the many pressing important questions which now confront the industry.

With all, the Industry still recognizes even in these trying times that "all work and no play makes Jack a dull boy." Ample time has been allocated to the competent Entertainment Committee for them to function. W. B. Hoey, Chairman, E. C. Maywald, W. T. Cruse and Charles Hamilton in best tradition promise a full program to satisfy the lighter requirements. Both golfers and non-golfers will be able to score according to reports being circulated concerning the plans. Announcements of the meeting will soon be sent out by the Society of the Plastics Industry. Reservations are now being accepted by Mr. Hoey, Stephenson Building, Detroit, Michigan.

★ TO SPEED SERVICE TO AIRCRAFT COMPANIES ON the West Coast, Röhm & Haas Co., Philadelphia, is building a branch plant in the Los Angeles area, scheduled to begin operation May 1. The new building will be devoted primarily to national defense work in the fabrication of Plexiglas sheets into cockpit enclosures, observation turrets, and similar transparent plastic parts for military planes. The new plant is the latest step in an expansion program which the company has undertaken to keep pace with the increased consumption of its plastic products. Its main plants are located at Bristol and Bridesburg, Pa., where in addition to plastics it manufactures organic and inorganic chemicals including products for the leather, textile, paper, insecticide and other industries.

★ DUE TO THE PRIORITY DEMANDS OF THE National Defense Program, the aluminum mills of America are reported to be unable to continue the supply of material to fabricators of aluminum products in the commercial fields. In view of this situation, the R. D. Werner Co., Inc., 380—2nd Ave., New York, finishers of extruded metal molding, recently announced a new line of plastic products, under the trade names "Plastikmould" and "Plastiktrim," manufactured in a wide range of colors in similar shapes and sizes as now supplied in aluminum; also rods, tubes, and other commercial items both flexible and rigid. P. C. Goodspeed is in charge.

★ WE REGRET TO REPORT THE DEATH OF GEORGE R. Meyercord, well-known figure in the plastics industry, founder of The Meyercord Co., and president and general manager of the Haskelite Mfg. Corporation. Mr. Meyercord will be remembered for his activities in the plywood field, particularly for the development of new processes and new applications.

★ IMMEDIATELY FOLLOWING THE NATIONAL PLASTics defense conference which was held in Washington on February 21st, the Board of the Society of the Plastics Industry acting on the Resolution adopted at that meeting proceeded to organize a defense committee, naming a representative group from all branches of the plastics industry. Rather than act precipitably following the Washington meeting, the Board designated a subcommittee to make a study and to recommend what in their opinion would constitute the most effective organization. Those serving, Roy Berg, C. W. Blount, T. W. Carswell, R. H. Cunningham, Chas. Romieux and Wm. T. Cruse, conferred on March 4th, and submitted suggestions to the SPI Board of Directors.

The Board acting upon this report appointed the following committee: C. W. Blount, Bakelite Div. of Carbide and Carbon Chemical Co.; T. S. Carswell, Monsanto Chemical Co.; Donald Dew, Diemolding Corp.; Wm. H. Milton, General Electric Co.; C. J. Romieux, American Cyanamid Co.; E. A. Stillman, Watson-Stillman Co.; Robert Titus, Synthane Corp., and Wm. T. Cruse, MODERN PLASTICS magazine.

As the organization begins to expand its functions it will be necessary to appoint subordinate committees to handle specific assignments. The defense committee is now at work compiling a complete industry directory which will be essential to assembling data. Facilities, services and personnel of SPI have been offered to the Plastics Industry Defense Committee to expedite their activity. The offices are at 295 Madison Ave., New York.

★ FURTHER EXPANSION OF GENERAL ELECTRIC'S facilities for the manufacture of plastic molded parts was announced by officials of the company who said that plans had been completed for the reopening and renovation of its former motor plant in Taunton, Mass., which increases the number of G-E plastics plants to five. It is expected that the new factory will be in operation in four months. Approximately 400 persons will be employed. Officials said that expansion of the Plastics Department's facilities has resulted from the tremendous requirements for plastics in the United States defense program, the consequent replacement of non-ferrous metals with plastics, and the natural growth of the plastics industry.

In this plant, there will be installed nearly 300 molding presses of the compression type which will give them more than half the capacity they now have at their main factory at One Plastics Avenue, Pittsfield, Mass.

★ ANNOUNCEMENT HAS BEEN MADE OF THE CONsolidation of Belmont Molded Plastics, Inc., into the Cincinnati Advertising Products Co., Cincinnati, Ohio. G. F. Mattman is president and treasurer, while R. C. Weidling has been named manager of the company's Plastics Division.

★ COMPLETE RETURNS FOR 1940 SHOW THAT AN intensive safety program begun four years ago in plants represented by the Cellulose Plastics Manufacturers' Association has cut lost-time injuries to 18 percent of the last reported rate for industry as a whole, it is announced by J. A. Burckel, chairman of the Safety Committee. The plants had a rate of 2.13 accidents for each million working hours in 1940 compared with the rate of 11.83 reported for U. S. industrial plants of all kinds in 1939, he said. The figures were compiled under standard regulations of the National Safety Council, which has not yet reported the 1940 average for industry as a whole.

The committee designated the Doyle Works of E. I. du Pont de Nemours & Co., at Leominster, Mass., as winner of the trophy presented in the annual safety contest conducted by the association. This plant, with 800 employes, operated throughout the calendar year without a single lost-time accident.

★ PRECISION PLASTICS CO., REPORTS THE REMOVAL of factory and offices to its new, enlarged plant at 1724 West Indiana Ave., Philadelphia. (*Please turn to page 100*)

Northern plus MAKALOT

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(B) The Low-Loss properties for which Makalot #1045 is famous add to the efficiency of National Company's coil-plate. It is also the best molding Low-Loss material yet developed.

(C) No introduction needed for this world-famous American Chicle Company counter display. You see them everywhere! A NORTHERN triumph in MAKALOT #1155.

(D) *MAKALOT #2962—No Shrinkage Cracks—Research Problem:* 6 inserts exposed at right angles in 2 levels plus 2 other inserts all cleanly exposed on both sides of complicated American Bosch Distributor Plate.

Solution: Makalot #2962 Brown for years has said a big "NO" to shrinkage cracking for Bosch and all other cracking around insert problems.

(E) Buttons molded of standard Makalot lead many a fashion-style parade.

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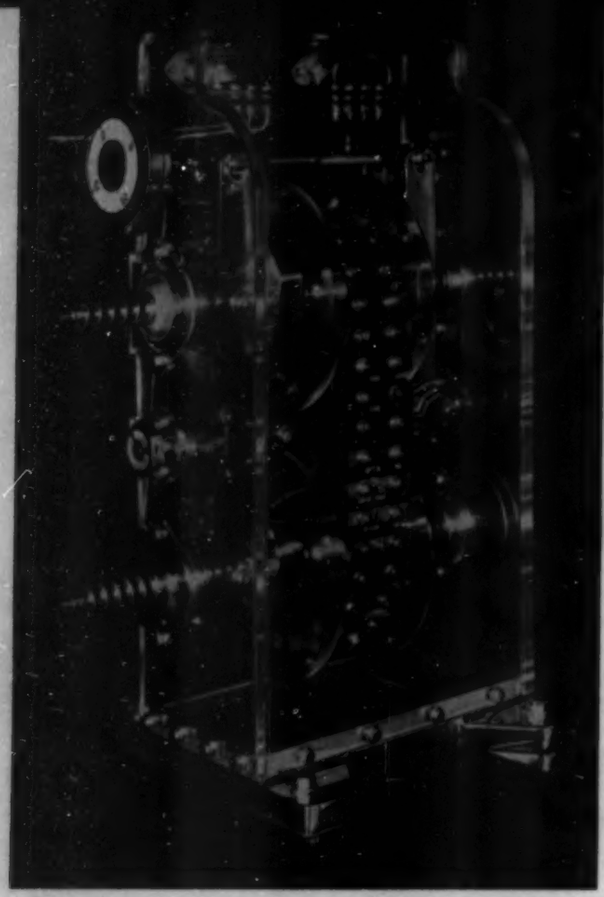


15 Plastic models

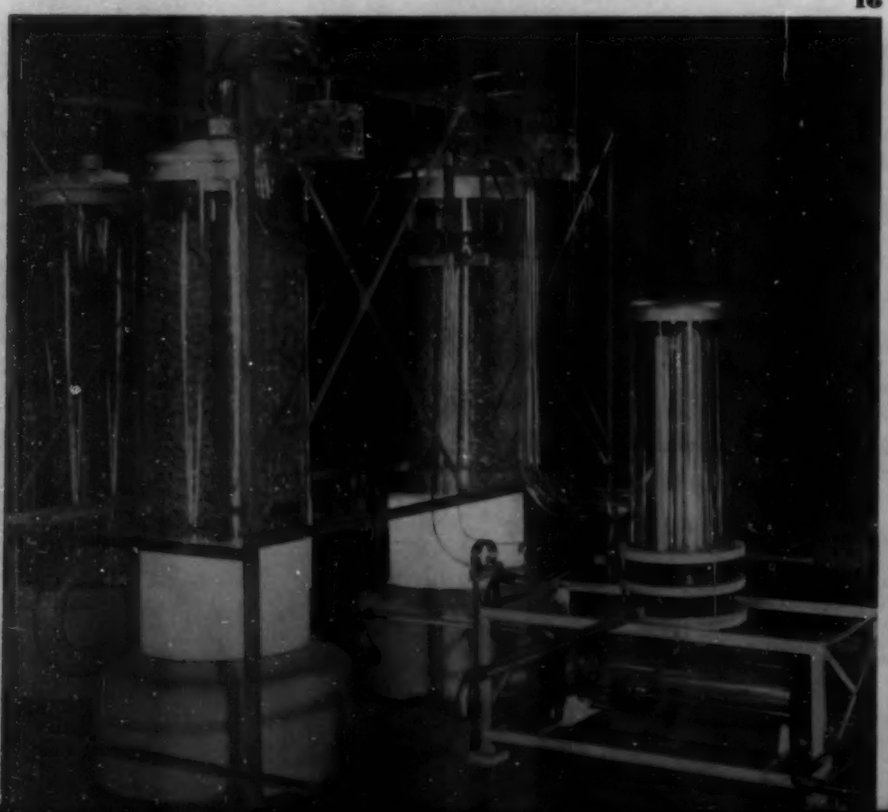
(*Continued from page 30*)

mind, but entirely devoid of precision and scale. These handmade models are generally fabricated from cast resin. Before the model makers turn a model, they make a mechanical drawing which shows the complete works of the product-to-be. In some cases, sketches of the exterior of the product are made so that the client can help visualize what his idea will look like when drawn to scale. As soon as the technical aspects of the item are proved, and, perhaps, some elementary changes made either in the mechanical parts or in the appearance, detailed drawings of each section are made up and these serve as guides to those who do the actual model making. When the model is finished for all to see, more changes are often in order, but these changes usually come as the result of a great deal of handling, plus pro and con discussion on the part of everyone from the top executives down to the sales staff and shipping room personnel. Models often go through without additional changes, but when the model has been okayed, it's "hi-ball" for the mold makers.

Plastics, for models, are replacing such materials as wood, metal, glass, plaster-of-Paris and even soap. The fact that there are transparent plastics is of great importance, particularly in industrial and experimental work. Actual working models housed in clear plastic give the engineers and manufacturers an X-ray view of the product's "innards." This type of material has proved its usefulness repeatedly in demonstrating the working principles of mechanical parts. Exact demonstration models in transparent (*Please turn to next page*)

15—The 4 disks and the housing of this variable speed transmission exhibit are made of acrylic material, in order that operating parts of the unit may be visible in action. **16**—An intricate, extensive and workable scale model of a refinery uses transparent plastic for some of its connecting pipelines. **17**—Simple but accurate shapes, readily formed out of transparent cellulose acetate material, facilitate design of the finished product

16



17

CONSUMER GOODS
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Curb on Aluminum, Other Items
Begins to Cut Into Output,
USE OF SUBSTITUTES GAINS
Plastics Employed on Items
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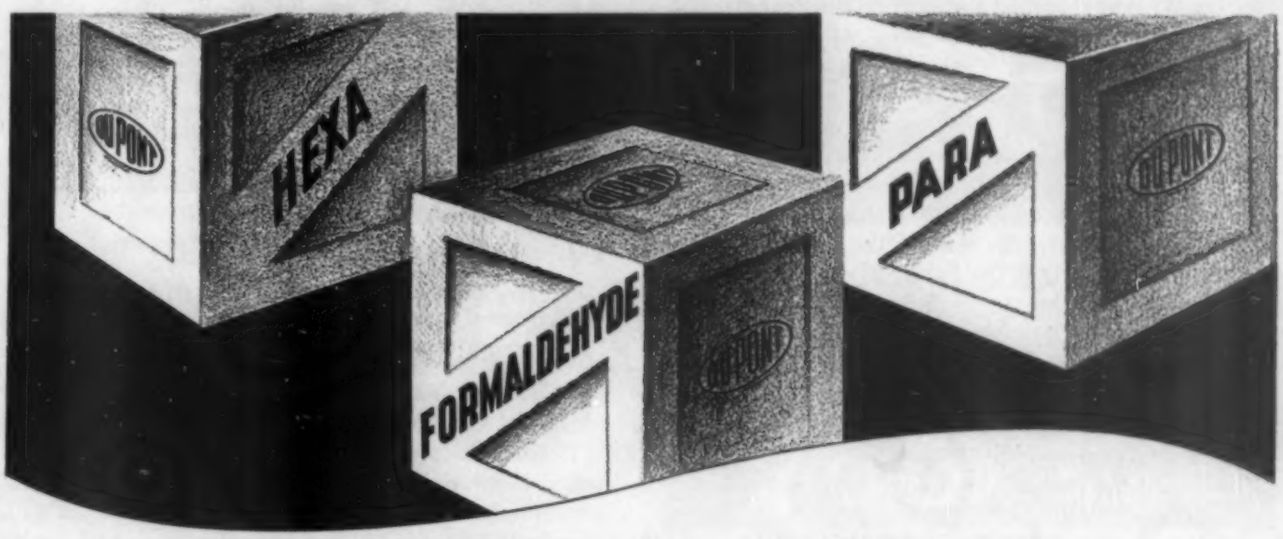

THE BUILDING BLOCKS OF PLASTICS

BASIC chemicals, Formaldehyde, Paraformaldehyde, Hexamethylenetetramine, etc., the building blocks of plastics, play an increasingly important part in the stable development of that industry. Modern production demands raw materials which are of uniformly high quality. Du Pont chemicals meet these requirements.

Du Pont specifications for its "P.A.C." Formaldehyde call for a full-strength U.S.P. solution, water-white in color, low in acid and low in metal content. Shipments, tested for these specifications, are made in modern containers and equipment.

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18

18—The model maker is a craftsman and artist working with all types of modern machinery that facilitate his work. Notice the funnel-like model fixed in one of the machines in the foreground. A larger plastic model rests on the worktable of the other workman in the rear

plastics of pressure reducing valves, bearings, gears, shock absorbers and other intricate mechanisms have been successfully fabricated with considerable dramatic value, too.

The fact that plastics are available in a practically limitless color range, from clear to opaque makes it possible to present models in exact shades and tints, in variegated hues and combinations of colors. Plastic models are easily cleaned and they retain their original, lustrous finish through long hours of handling and speculation. Precision, workability, pleasant surface and comparative light weight are added advantages.

Strictly speaking, the model maker does not in any sense assume the role of industrial designer. His job is to carry out a three-dimensional interpretation from the specifications of the stylist. A model maker's work might be compared with that of the toolmaker; the basic difference is that the former is concerned with a single pre-production, third-dimensional model while the latter deals with an interpretation in a mass production medium. There is no conflict, or at least there should be no conflict, between the model maker and the industrial designer. Rather, their work should be entirely harmonious. The basic difference between the two is that the designer is vitally concerned not only with production, but with sales, appearance and merchandising. In fact, every angle that is related to the final consumer acceptance comes into the ken of the industrial designer. The model maker concentrates on a faithful, craftsman-like reproduction of the article.

There are surprisingly few good, dependable model makers in this country. And there is a big demand for them! The reason for the small number engaged in this profession might seem obscure at first, but a glance at some of the models turned out by this sparse group more or less answers the question. Model making is a precision job. To make a good model requires almost as much time, accuracy and patience as the making of a mold. While some well-equipped shops can turn out models at a fairly good rate of speed, the work is by no means in the mass production class. Most of it is done by hand, and this requires time and close attention to detail. The complaint of most model making firms seems to be that they have more work than they can do and are unable to find any satisfactory help. Capable assistants are at a premium.

Credits: Material: Bakelite, Catalin, Lucite, Lumarith, Marblette, Opalon, Plastacele, Plexiglas, Pyralin, Tenite. Stricker-Brunhuber, Swedlow Aeroplastics Corp., Leslie Rupperl, Reeves Pulley Co., Inc., DeVilbiss Co., E. Norris Brown, General Electric Co., Earl S. Tupper, Waller Dorwin Teague, Martial and Scull, Scientific Engineering Co., Sundberg-Ferar, Classic Studios, Barnes & Reinecke, Carl Ford, Inc., Transparent Plastics Products Co.

Electroforming molds

(*Continued from page 32*)

of the cavity mounted on a plate—a so-called "matchplate" where the parting line and land will be created along with the cavity.

Untreated wood patterns will give cavities carrying raised impressions of the grain which, in turn, permit the reproduction of the wood surface in plastic. Fig. 7 shows plastic loose leaf covers in duplication of a mahogany veneer pattern; the molding is in solid color while a contrasting color is wiped into the grain depressions. The successful refinement of this technique has created interest in molded gun stocks, pistol grips, horn buttons, radio cabinets, table tops, garnishes and trims carrying a wood grain surface.

The opportunity to produce mold surfaces impossible by other methods of fabrication immediately includes molded plastic leather grains, examples of which are shown in Fig. 8. The pattern consists of the desired shape covered with natural or imitation leather.

(*Please turn to next page*)

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10—Electroformed molds reproduced intricate raised designs in this dresser set by Pro-phy-lac-tic. **11**—A carved stone cameo is reproduced in plastic by the same method

Molded plastic shoe heels, portable radios, compacts, cigaret cases, and automobile appointments are a few of the items where the cost of applying leather as an extra operation may be eliminated.

The next important question asked about electroformed molds is about that which will be obtained. As formed, the cavities will exhibit the finish of the pattern as in Fig. 9 where a watch crystal was used as the starting point. However, cavities for large production require hardening and the surface becomes coated with a dark carburizing scale which must be polished off to restore the finish. A highly polished surface requires less polishing after carburizing than an average surface as obtained, for instance, from a plaster pattern.

The increased demand for molded plastic lenses has demonstrated the necessity for a dense uniform steel and many careful polishing operations when producing lens cavities in the usual manner. Since glass is somewhat easier to polish, it is highly desirable to use this material as a pattern and create electroformed cavities in the polished condition. Both the hardening and annealing operations are eliminated with such electroformed cavities and a nickel face which may be augmented with chromium is supplied. This gives inserts with a Brinell around 240 suitable for moderate production requirements. The nickel face is obtained by electroforming with nickel prior to applying the iron.

Finally the molder is interested in where electroformed cavities may be used to greatest advantage. Generally speaking, the best applications are threefold:

1. For unique surface finishes such as wood grain, leather grain or a fabric weave.
2. For cavities which are difficult to hob or engrave.
3. For reproduction of an existing design.

Under the second classification are particularly scales, dials, and intricate designs requiring raised areas in the mold cavity (Fig. 10). It is a relatively simple operation to engrave or etch a design down into metal and use this as a pattern to produce corresponding raised areas by electroforming.

A molding for which the cavity was difficult to hob is a fish bait of cellulose acetate which is of awkward shape while the extreme case is probably represented by molds for plastic reflectors. Here the face of the cavity is divided into prisms or squares requiring polished faces and accurate angles. Expensive master molds prepared with fitted pieces can be duplicated economically with this method.

The exact reproduction of existing artistic designs without destroying the master is shown in Fig. 11. The carved stone cameo represents an article now disappearing from the jewelry counters since their importation has been shut off. One of the originals used as a pattern will yield any number of cavities for the molding of perfect reproductions in plastic materials.

Credits: Ekko mold process developed by U. S. Rubber Company

Tailored trimmings

(*Continued from page 44*) very important, since the edges of chairs and sofas are usually the first places to weaken under the stress and strain of constant wear. In addition, the unusual beauty and elegance of the material adds originality and éclat generally lacking in such a prosaic thing as upholstery detail. Moreover, the inherent elasticity of the plastic provides a welting material that will not stretch out of shape.

Non-porous and completely waterproof, the plastic is unaffected by moisture or other liquids. It is readily washable, a highly practical advantage in upholstery materials. The thinnest strands make the softest of flowing fringe for modern fabric draperies, hanging straight on the bottom, or cascading gracefully down the vertical side of the curtain.

One of the chief beauties of the plastic for decorating use lies in the charm and glamor it takes on under light, either artificial or daylight. It also has the faculty of increasing the light intensity, thereby lending new interest to both modern or traditional interiors.

Credits: Vinylite; trimmings designed and fabricated by Paul MacAlister, Inc. Extrusion by Irvington Varnish & Insulator Co.

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Aircraft plywood, adhesives

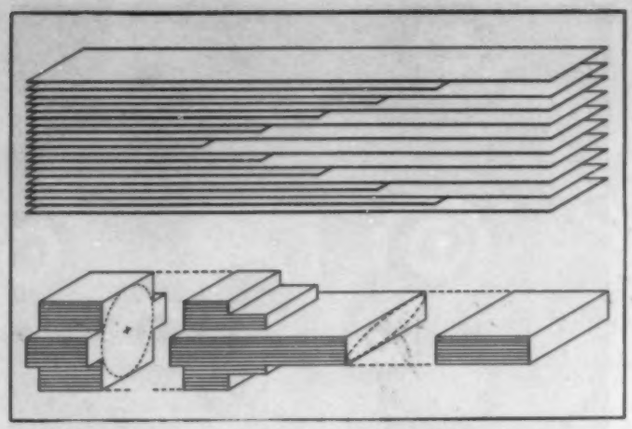
(*Continued from page 58*) spondingly lighter. Plywood can be glued to the ribs and spars, while metals have to be riveted, a distinct disadvantage. The springiness of plywood renders it less easily damaged and if damaged it is much simpler to repair.

Certain combinations of plywood thickness and curvature can be bent cold and dry. If the curve is too severe, phenolic resin-bonded plywood can be softened by steaming and then bent and dried over either a single or double form, which may be heated. Sometimes rather sharp curves are facilitated by bending at 45 deg. with the face of the plywood, rather than parallel to any layer within the plywood. It is becoming increasingly apparent that thicker skin coverings, at such locations as leading edges, may permit the elimination of a substantial number of ribs, with consequent reductions in time, weight and cost. In some cases these thicker plywood surfaces may consist of several layers of 2-ply, bonded together as suggested in Fig. 4–IV, with rubber bag pressure.

(*d*) *High density reinforcing plates.* Solid lumber, such as the spruce used in spars, splits easily and has very low bolt-holding power. Hence spruce spars require sturdy reinforcement where they are attached to the fuselage or landing gear. While this is often done with metal plates, it is possible to get very excellent results from the use of reinforcing plates of high-density plywood, of which the strength characteristics are given in Table 2 (46). It is to be noted that the resistance to shear is increased some seven-fold, as between solid wood and plywood pressed at 1000 or 1500 lbs. specific pressure. While both solid maple and normal-pressed plywood (200 lbs. p.s.i.) are used for such reinforcing, the denser product offers distinct advantages in the weight/shear ratio, i.e., where shear resistance increases some 700 percent, the specific gravity or weight increases only 114 percent.

One important factor in using high-density plywood for reinforcing plates is to have the surface adjacent to the soft wood sufficiently roughened so that the bond will be both mechanical and adhesive. A simple way to accomplish this is to have one surface of the high-density plywood pressed (as it is made) against a knurled plate, or even against a properly proportioned metal screen, so that the resulting ridges and valleys are from $^1/_{32}$ in. to $^1/_{16}$ in. high and not farther than $^1/_8$ in. apart. Such a roughened surface can be pressed into the spruce by the bolts and will result in a mechanical grip of unusual strength. While the spar is the most obvious place on which to use high-density plywood reinforcing plates with mechanical interlocking into the wood surfaces, there may be other locations where such strength developments can be well utilized.

(*e*) *Propeller constructions.* Progress in the propeller field is rapid, and it would be venturesome to predict the extent to which wood and plywood, with its newly developed attributes of high density, may enter the field of propeller design. At present many, if not most, of the double-blade straight propellers for "cub" planes are laminated wood, built up out of $^3/_4$ in. birch, mahogany or walnut lumber, and this type of construction seems well established.



6—Laminated propeller blanks with differential density. Upper: Method of assembling ½ in. layers from thin veneers, using extra layers to give additional density at hub end. Unit pressed and bonded to uniform thickness. Lower: Combining is the above layers into the propeller blank with adequate thickness for hub anchorage and sufficient width for required blade dimensions. Dotted lines indicate approximate final shape

As the service becomes more exacting on larger airplanes of the various trainer types, there is a tendency to use two single blades, mounted on a straight line, in metal hubs provided with clamps that permit adjustment of pitch on the ground, but are in fixed position during flight. Here plywood fits the requirements adequately, and the blanks may be made with high density at the hub end and low at the tip, as is outlined below for larger sizes.

Large single-propeller blades have been made of wood, using $^1/_2$ in. thick strips of very dense "Jicwood" or "Pregwood" at the hub end (41). This dense portion is scarfed onto spruce for lightness toward the tip end, where gripping power is not essential. These laminae are built up into suitable blanks for blades that may approach 12 in. in width and 10 ft. in length.

Another type of propeller construction is built up from $^1/_2$ in. thick laminae made on a variable density basis as shown in the upper sketch of Fig. 6. The veneer layers (25) are varied in length to give such density as strength requirements may dictate at any section in the propeller. In general, the aggregate thickness at the hub end will be some 175 percent of the final thickness and at the tip approximately 115 percent. The whole is hot pressed with resin film to a uniform thickness controlled by metal thickness separators in the press. The density requirements may be varied by the species, the bulk and the pressure. In some instances it may be desirable to cross-lay the shorter layers of veneer, but this will depend on design requirements. These $^1/_2$ in. laminae are then built up into the desired size blank, of which a type is shown in the lower sketch of Fig. 6. The dotted lines indicate

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approximately the final shape. Developments in wood propeller design are likely to become increasingly important in the near future.

Status of government specifications

The Army and Navy specifications for aircraft plywood have been combined in AN-NN-P-511 (49) and stipulate two grades of plywood, *Standard* and *Waterproof*. In the latter, the soaking and fungus tests eliminate all adhesives except the resins. In the matter of assembly adhesives, the Army and Navy publish separate specifications (50, 51).

Physical properties of plywood

Fundamental data on the strength characteristics of solid wood are well established. It should be noted that the behavior of wood under stress loadings is sometimes quite different from that of metals, since wood is relatively non-homogeneous, while most metals are quite homogeneous. Most technical information on the strength of materials has been in the metal field and has been based on the behavior of metals. Since wood reacts quite differently from metal in some respects, it is not always possible to consistently compare the performance of wood and metal. And as a consequence some of the desirable qualities of wood have not been adequately recognized.

Plywood, while depending for its strength characteristics on the strength elements of the various sheets of veneer of which it is composed, still presents several new qualities of distinct value. In addition, there are many principles of design and types of construction in plywood that, under intelligent application, can be utilized to secure special strength requirements that far exceed the normal in either wood or plywood. It is for this reason that plywood offers unusual advantages to the aircraft engineer. It is obvious that these special plywood advantages can seldom be expressed in standard tables of strength characteristics, but must be evaluated in terms of understanding in the use of plywood, and from experience in its application.

Fundamental data on wood strength are given in "Strength of Aircraft Elements, ANC-5" (52) issued by the Army-Navy-Civil Committee on Aircraft Requirements. The practical usefulness of these data has been enhanced by the engineers of a leading aircraft plywood manufacturer,[4] who have rearranged these fundamental data for the types of plywood customarily used in recognized aircraft design (48*c*).

Conclusion

It becomes apparent that plywood, with the improved resin adhesives now available, offers to airplane designers and builders a material, the desirable characteristics of which have been seriously underestimated. The more recent techniques of thinner veneers, multi-plies, various arrangements of cross layers, high pressures and degrees of resin impregnation, afford opportunities for special strength combinations that will successfully solve many problems in the aircraft design of the not far distant future.

[4] The Haskelite Mfg. Co.

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(*Please turn to next page*)

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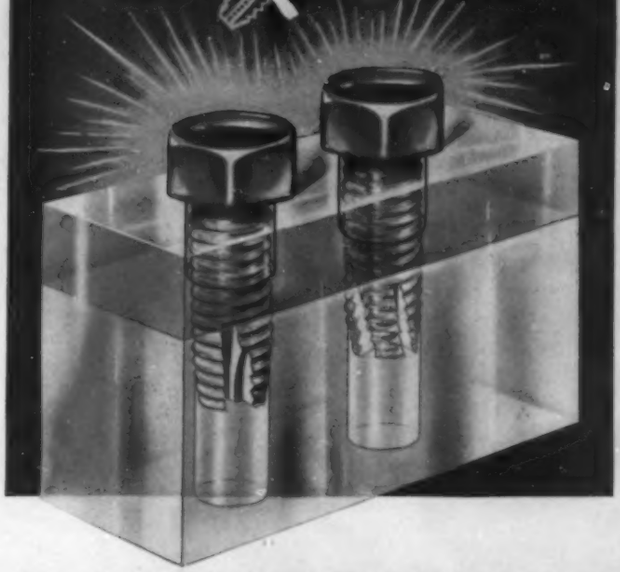

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Pastel veneers

(*Continued from page 43*) can be thrown upon the surface for intermittent periods without damage to the finish. This heat-resistant quality is very important when furniture is placed near a radiator or hot-air register. Exposed to the direct rays of the sun, the veneer will not discolor. Hot dishes can be placed on veneered table tops and will leave no mark. This material may be cleaned with ordinary cleaners and soaps and is unaffected by oils, acids, nail polish and even many stronger solvents such as lacquer and varnish remover. Furniture polish is not necessary to maintain the original luster.

Fabricated under patentable gluing processes, this new plastic veneer may be used in the same manner as wood veneers. In appearance, this material has a textural effect achieved by a photographic process. A fabric or special design is photographed and printed in color on rolls of paper. This photographed grained paper is then used for the top layer in the series of laminae. The veneers are opaque and are available in any color, including black and opaque white. While two textures were stressed in the initial showing, one a tweed-like mixture, the other an iridescent snowflake pattern, the manufacturer states that any textural effect or color is possible. Used in plain and figured combinations, in monotones and in two-tone contrasts, and in many instances combined with rare woods, the plastic veneered furniture is setting a vogue that is as practical as it is beautiful.

Resistant to vermin and termites, this flexible veneering is non-warping and can be applied to any type of surface: plaster, fiber board or plywood. It possesses fine thermal and electro-insulating qualities and is lightweight. The amazing wearing qualities of the veneer are topped only by its unusual color and textural effects.

Credits: Material, Plastyle Veneers, Inc. Pulls are Tenile. Piano by Wurlitzer. Furniture by Saginaw Furniture Shops, Inc.

Plastic gas mask lenses

(*Continued from page 40*) good enough aging qualities to make them quite satisfactory for military use. No small part of these good points is due to recent improvements in composition of the materials and in molding or manufacturing technique.

The eyepiece in the Training Gas Mask is known as a cylindrical molded plastic lens. While both cellulose acetate and methyl methacrylate materials may be used in the manufacture of these eyepieces, recent orders have been filled by cellulose acetate material. This is due in part to the fact that eyepieces made from cellulose acetate are stronger than those made from methyl methacrylate and also due to the fact that molders seem to prefer to work with cellulose acetate because of economic considerations. The fact that cellulose acetate is cheaper and is procurable from more sources than methyl methacrylate may have something to do with the popularity of the cellulose acetate material.

The molding of the cylindrical plastic lens is a most difficult one. The success obtained is very definitely related to the proper molding powder, the mold and the molding technique. Just how to properly distribute the weight of importance to these three factors has not been accurately determined. The Chemical Warfare Service does not attempt to control the molder in his choice of molding material, mold construction or molding technique. Definite standards of performance and dimensions are set up for the finished eyepieces which the molder must meet the best way he can. In this connection, it is important to note that the specification for this lens has very rigid optical and dimensional requirements and close tolerances. In spite of this, the problems involved in the molding of these eyepieces have been solved by several molders with the result that the eyepieces can now be procured commercially in quantities large enough to meet military requirements.

The eyepieces of the non-combatant gas mask do not present the problems of manufacture that are found in the manufacture of the molded eyepieces. The most serious problem with this eyepiece is the one of fogging. The construction of this gas mask is such that fogging of the eyepieces is likely to occur. This problem can be solved by putting some material on the eyepieces that will eliminate the fogging condition. When this has to be done by the wearers, scratching of the eyepiece is a certainty. To avoid unnecessary scratching of the eyepiece and to reduce to a minimum the things the user of such a gas mask must do, it would be desirable to have the eyepieces supplied with a non-fogging compound before they are assembled in the gas mask. Fortunately, industry is able to supply sheet or film cellulose acetate so treated that it will resist fogging. Since this material can be procured from several sources, non-fogging sheet or film cellulose acetate material is required for the non-combatant gas mask eyepieces. Recently, vinyl resin has be-

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➡ **WANTED:** Vinylite scrap from punchings or moldings. Any colors. Good price paid for clean material. Reply Box 431, Modern Plastics.

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➡ **WANTED: PLASTICS SCRAP OR REJECTS** in any form, Cellulose Acetate, Butyrate, Polystyrene, Acrylic, Vinyl Resin, etc. Also wanted surplus lots of phenolic and urea molding materials. Reply Box 318, Modern Plastics.

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come available in transparent sheet material. This material has been proved to be satisfactory and is now included as one of the materials a manufacturer may use in making the eyepieces for the non-combatant gas mask.

Great credit is due to the plastics industry for making it possible for the Chemical Warfare Service to substitute transparent plastic materials for glass in the manufacture of the gas mask eyepiece described. The Chemical Warfare Service has been very ably assisted in the development of these materials by the molding powder manufacturers, molders and the technical staffs of these organizations. Without this help, the present state of development could have been very easily delayed by several years.

In closing, I wish to leave with you the most difficult problem that the Chemical Warfare Service has met in the use of plastics. To date, very little success has been achieved in the various attempts to reduce the effect of liquid chemical agents and disinfectant materials on plastic materials. In the case of gas mask eyepieces contact with liquid chemical agents renders them practically useless. The eyepieces are discolored and etched to such an extent that satisfactory vision is impossible. For training purposes, this is not a matter of importance but under war conditions it is a very serious matter. For this reason, and because of resistance to scratching, the eyepieces in the service gas mask are made of laminated glass. Glass, while it is difficult to assemble in the shape required, is unaffected by liquid chemical agents. The fact that glass eyepieces of the right size and shape are more difficult to procure makes it very desirable that all possible effort be made to secure a transparent plastic material that is highly resistant to the action of liquid chemical agents and disinfectants used in keeping the masks in a sanitary condition. Let me state that it has been a pleasure to come before you to discuss this problem with you. We hope the plastic industry will improve our product materially and soon.

Freighter deluxe

(*Continued from page 41*) catching dial numerals are engraved on the back and the hands are attached from the rear so that the front surface is absolutely smooth. Table, bar top and various furniture and work top surfaces are of cigaret- and alcohol-proof laminated plastic material.

The architects for these ships claim that they use plastics wherever possible. Corrosion, always a problem at sea, made plastics an automatic consideration wherever they could be adapted to serve economically and with durability. The chairs in the lounge have black anodized aluminum frames, sturdy transparent methyl methacrylate arms and are upholstered in clay beige leather. In the verandas, a bookcase of breakfront design features mirrored doors embellished with clear plastic rings. Washable, lightweight, and corrosion-resistant light fixtures for the walls are molded of ivory urea. These wall bowls are a standard item having been used on the *S.S. Panama*,, but were slightly redesigned for this boat. Below deck, plastics are used in abundance. Such applications as electrical parts, insulation, knobs for controls and levers are an old story, but always an important one.

Light-catching dial of this handsome clock is carved on the back of a clear curved methyl methacrylate sheet illuminated from within the case. Base and top of this large buffet timepiece are cast resin

All of these plastic applications, both utilitarian and decorative, will be repeated on all six vessels, so that there will be an approximate total of 6 specially designed and comparatively expensive clocks, 66 plastic lamps, about 204 molded light reflectors, and enough square feet of laminates and phenolic material to identify plastics as a vital material in the shipbuilding field.

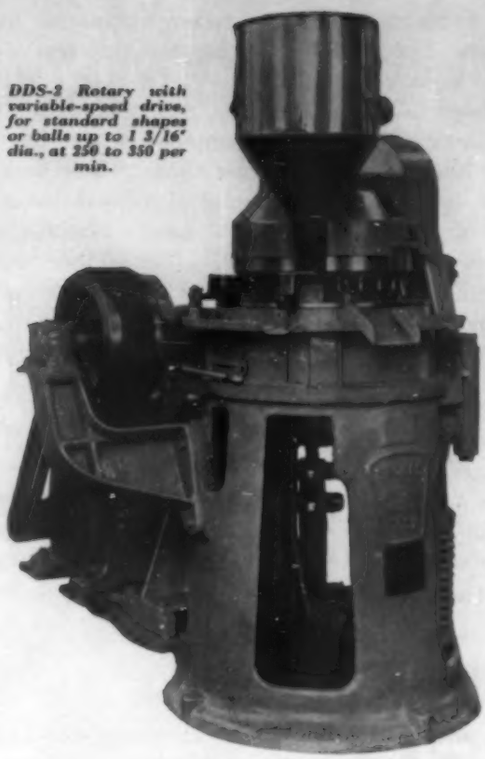
Credits: Formica; Lucite and Plexiglas lamps by Swedlow-Lehman. Lucite chair arms by General Fireproofing Co.; Catalin and Lucite clock by Accessory Timepieces. Plaskon and Textolite reflectors by General Electric Co. Designed by George G. Sharp.

Toying with nitrocellulose

(*Continued from page 45*) and then assembled. Within recent years, important improvements in the manufacturing operations have been accomplished through refining the designs, by obtaining more precise detail in the toys and by originating semi-mechanical decorating and assembly means.

Nitrocellulose continues to remain the only material which is extensively used for manufacturing floating, lightweight toys because of the ideal working characteristics of its physical properties. It offers unlimited colors; shades of red and white are the most popular. It is easily decorated with lacquers and paints. Being relatively non-hygroscopic it withstands the wet blowing operations well. It does not blush and remains securely bonded at all weld lines. Because the articles made from it are sanitary, colorfast, smooth-surfaced and far from fragile, they make "safety first" toys for infants and children.

An important manufacturer in the industry reports that although before the war this country relied on German shops for toy dies, now domestic tool makers



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were being developed. The importance of having domestic tool sources insuring the delivery of dies cannot be over-emphasized.

Related to the revival of the nitrocellulose toy field, are plastic Christmas tree ornaments sold by chain stores last season for the first time. These were also blown, but by an entirely original method and with a different plastic raw material base. Machinery has been developed for automatically blowing thermoplastic molding powder. These ornaments of cellulose acetate were produced on this equipment. However, up to the present, no other commercial production on toys or other articles by this method has been reported.

During the year 1940 the domestic sales of nitrocellulose toys was approximately $1,500,000. If the present production rate is maintained, with new developments taken into account, and if foreign competitors remain out of the market, the output for the current year should exceed that of 1940 by a substantial margin.

Credits: Monsanto Cellulose Nitrate; Fabricated by Noveloid Co.

Lady in the dark

(*Continued from page 35*) gazing upon a blue setting which has for its background a series of large blue screens measuring about 20 ft. high by 3 to 4 ft. wide. Each of these units is completely covered with cellulose acetate, the plastic having been applied in liquid form and allowed to dry. The effect is rather frosty—here and there the acetate was rubbed off before it dried so as to permit a brilliant blue foil on the screen itself to show through. This "crumpled" finish catches the light with reflections that would have been impossible with canvas, cloth or wood backgrounds.

This type of plastic treatment has been used in all of the dream scenes. The screens, railing and balustrades, trees, lanterns, an entrance to an apartment, large dressing table, chairs, sofas, a so-called automobile, portals, chandeliers, a wedding cake (14 ft. high), a switch box, bottles and glasses for the night club scene, an illuminated postage stamp (5 ft. by 6 ft.), candle holders, telephones, simulated glass brick windows and a lamp post are all constructed with this plastic. In some instances, the material has been applied on a lace overlay, and although this is not apparent to the audience, the lamination of lace and plastic does have an effect upon the way the lights strike the material and the reflection. In specifying the use of lace, the designer felt that it helped to carry out the underlying theme—fashions and femininity.

In all of the fantasy or dream scenes, letters, telegrams or messages are printed (or presumably so) on sheets of clear glistening acetate. This use of plastic material in this instance not only is in keeping with the "unreal" atmosphere but it is ideal from the property man's point of view—it will stand up without frequent replacement.

It seems that everyone is delighted with the use of plastics for the setting in this show. Not only is the

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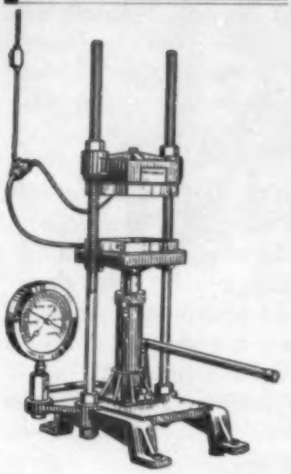

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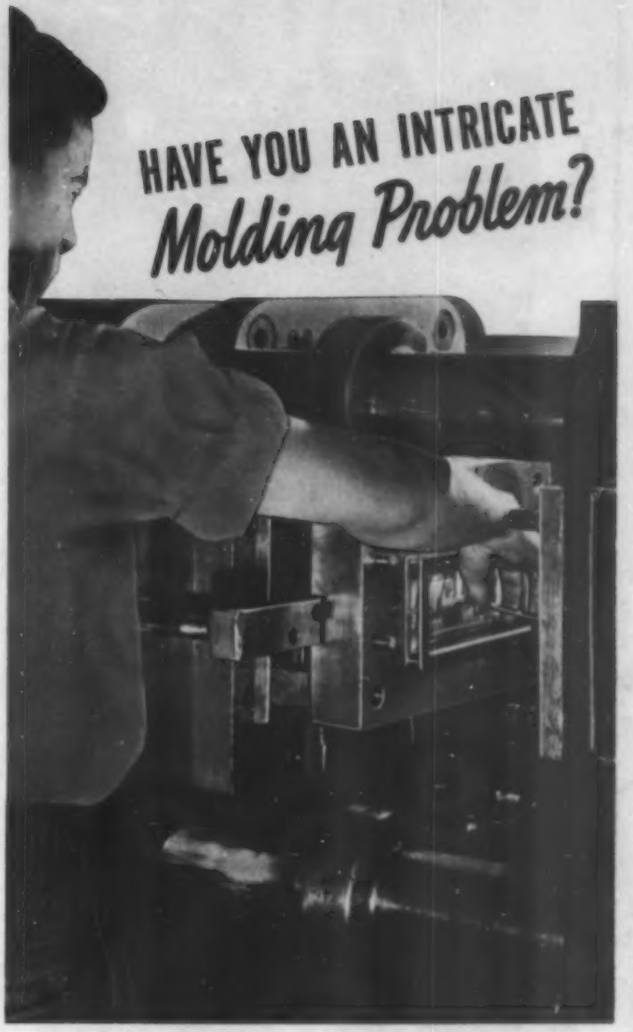

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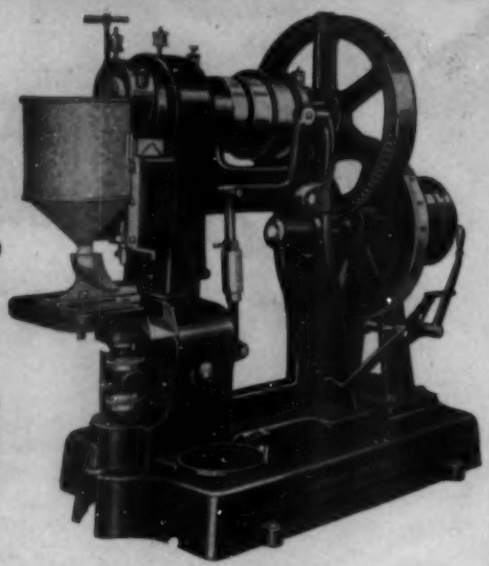

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material flame-, alcohol- and water-proof, and durable but the fact that the plastic material adds comparatively little to the overall weight is a joy to the weary stagehands who have some quick "fixing" to do for the rapidly changing backgrounds.

And now a word about the development and application of this type of plastic. It has been used for several years for various stage settings, for manikins, statues, Christmas bells and wreaths, window displays, large decorative globes, vases, plates and many other decorative objects.* The basis of the product is cellulose acetate flakes. These are mixed with various plasticizers and other ingredients depending upon the use for which the article is intended. The company claims that it can make the material as soft and pliable as silk, or hard as a rock, if necessary. Just as there are various grades of phenolics for different applications, so this plastic can be made flameproof, resistant to alcohols and weak acids. In short, they not only do custom work, but the material itself might almost be said to be "custom" material.

"We use plaster, metal or rubber molds," says the fabricator. "The material can be applied either on top or inside of the mold, and we can use either male or female molds. We have made full and half-relief figures and plaques with and without undercuts. All of these articles are always made in one piece. This comparatively new method of producing large or small articles in plastics without expensive molds and large presses has been accepted very enthusiastically by many of the foremost interior designers.

"This is a unique means of producing translucent statues and other art objects without losing any of the detail and without the expense of steel dies. We have successfully executed many decorations and statues for several churches in Czechoslovakia where this type of work was introduced for the first time in 1935."

The basic ingredients used in this plastic technique are a secret to no one, but it appears that the special mixing and handling methods are the most important factors in the final products which are special custom, artistic achievements. Each article made is considered an individual problem and the work is all handled by skilled craftsmen. Suffice it to say that the applications of this plastic are extremely interesting. It is proving its superior qualities in many places and under all sorts of conditions.

Methyl methacrylate has been used in the *Lady in the Dark* for an artist's palette, for a large key—that looks as though it might be the key to a city—and for the graceful, ethereal lyres used by the heroine's serenaders—all used in the dream scenes.

Perhaps, you will have to see the play twice, because you may find it difficult to watch for all the plastics and still keep your mind on the action—there is almost as much "plastics" as show!

Credits: Lamicoid (not shown). Marolin by Joseph Mrazek. Lucite fabricated by Leo Prager. Designer, Harry Horner.

* Called Shellflex, see *Modern Plastics*, January 1939, p. 30.

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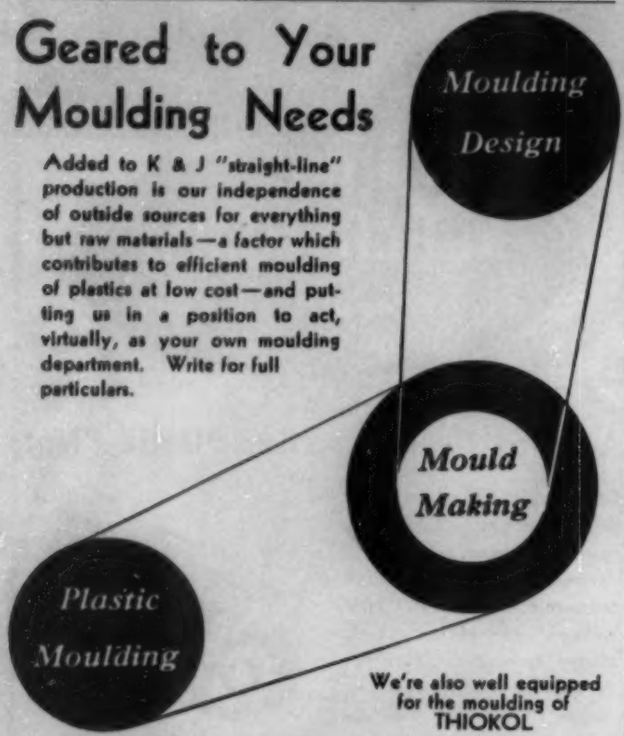

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Flammability of plastics

(*Continued from page 60*) long period. Possibly slight variations in ventilating conditions during the test would affect results obtained.

The amount of material burned, as reported by co-operating laboratories, did not seem to check as well as the burning time data. This was most likely due to a need for a more accurate description of the method to be used for measuring that area. Several suggestions were offered for doing this which have been incorporated in the final test method.

Another interesting point brought out in a discussion of these tests was the need for protecting the operator from the effects of toxic fumes which might result from burning some materials. Hence, a recommendation was made for conducting the tests in a standard ventilating hood with ventilating fan turned off, with the added precaution that the fan be turned on immediately after completion of the tests to exhaust the gaseous products of the burning. The reason for turning off the exhaust fan during the test is that draft conditions in the room or chamber in which tests are made seriously affect the results in spite of the use of a shield in which test strips are actually burned.

After this series of tests was completed there still seemed to be questions on procedure which had not been properly answered and hence a third series of tests were run on eight film materials by five laboratories. In this series particular attention was paid to two points: first, the use of a 4-sided or enclosed shield against a 3-sided open shield; and second, a comparison of the fusee type of ignition as compared with a benzol drop method. The results of the tests are shown in Table III.

An examination of these data indicate very little difference between open and enclosed shield except that variations are apparently smaller where enclosed shield was used. A comparison of the two types of ignition shows little choice, but personal reactions of operators favored the use of the fusee method as being slightly more convenient. As the result of these series of tests the test procedure was then set up and adopted by the American Society for Testing Materials as a tentative standard method of test.[9]

As indicated by the scope of the method of test it is intended primarily for determining the flammability of sheet and film materials in thicknesses less than 0.050 inch. The test method describes a method of making the test, the results of which may be used as a basis for specification requirements for this property of these materials. The widespread use of plastics in forms other than sheet and plate materials makes it desirable to have a standard procedure which might be used for evaluating the flammability or rate of burning of plastics in some of these other forms. Such work is under way under the supervision of the same committee responsible for developing this method. It is quite likely that such a method of evaluation applicable to plastics in other forms will be available. (*Please turn to next page*)

[9] A.S.T.M. Designation D 568-40 T.

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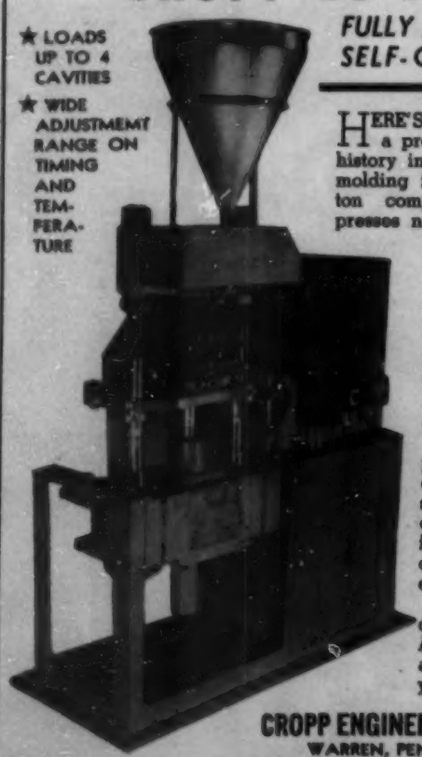

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Particular thanks for information contained in this communication is due to the six laboratories and individuals in those laboratories who cooperated in conducting the tests described herein. The individuals and laboratories responding were as follows: J. H. Teeple, Plastics Department, E. I. du Pont de Nemours and Company, Inc.; H. R. Dittmar, Ammonia Department, E. I. du Pont de Nemours and Company, Inc.; G. M. Kline, National Bureau of Standards; E. O. Hausmann, Continental Diamond Fibre Company; M. C. Reed, National Carbon Company; and E. A. Wilson, Monsanto Chemical Company.

Impact molding materials

(*Continued from page 40*) preforming qualities.

The specification of shock-resistant molding materials by both the Army and Navy for a great diversity of parts which in everyday commercial practice could be satisfactorily molded of general purpose compounds is necessitated by the consideration of great stresses suddenly applied by the detonation of heavy guns and high explosive charges in the vicinity of combat equipment. The severity of such sudden stresses requires that equipment be of most rugged construction throughout.

Shock resistance is considered of primary importance by the Navy in such parts as instrument cases for aircraft and marine use, terminal blocks for an infinite variety of important electrical connections, junction boxes for submarines, and circuit breaker boxes for use on all types of craft. Similarly, parts used by the Army include aircraft instrument cases and control devices, fuse timers for shells, and electrical fittings for tanks and trucks.

The Bureau of Ships, Navy Department, has written specifications covering phenolic impact molding materials as such, irrespective of the molded parts in which they may be used. Since these specifications recognize several groups of shock resistant materials and are indicative of the properties encompassed by such a range, a table of molding material characteristics has been prepared which includes three compounds recognized either finally or tentatively by these specifications.

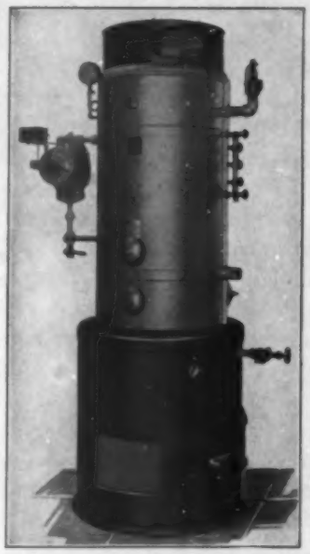
The Navy classification designation and the general types referred to heretofore in this discussion may be correlated as follows:

Type 1	CFI-5
Type 2	CFI-10
Type 3	CFI-20

The CFI-20 specifications have been in use for some years and are complete. The CFI-10 specifications have not been issued yet with final values for each property, but a specific molding material has been approved and has been used for some applications for several years. The CFI-5 classification is a tentative one in which a specific molding compound has been suggested but to date has not been used through lack of specific requests from molders for permission to use it. It is

MKAYO

boiler for oil firing



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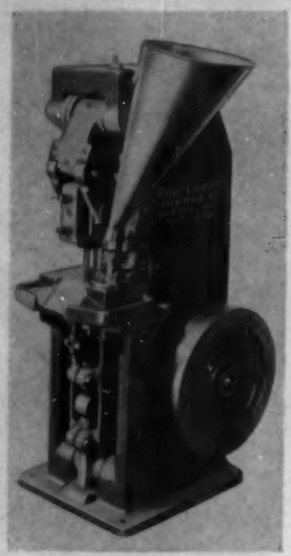

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recognized that there are some parts for which molds have been built to handle the volume of CF-6 material and which are subsequently discovered to be insufficiently shock-resistant for their intended use. In such cases the CFI-5 material can usually be handled in the same molds and offers an impact strength of 1.5 to 1.7 times that for CF-6 material. It is intended that where the need for shock resistance is foreseen, the mold will be built with sufficient loading space to accommodate the bulkier CFI-10 and CFI-20 materials.

Examination of Table I will indicate that relatively high impact strength values are obtained among these three groups with a sacrifice in bulk factor, water resistance, and general moldability. It should be emphasized that where these limitations are recognized in advance adequate allowance can be made in mold design and piece design so that the full impact strength of CFI-20 material can be utilized. (See page 100.)

The three materials have been ranked 1, 2, and 3 according to moldability. This is based on practical molding considerations covering several factors: the ease with which intricate corners of a mold can be filled out, the ease with which a mold charge can be placed in the cavity, and the necessity of using special technique such as breathing or chilling the mold in order to insure the production of well-filled, dense parts, free of blisters and other internal defects.

Due to the high bulk factor and limited flowing characteristics encountered to an increasing degree in the higher impact strength groups several practical considerations merit attention before parts are finally designed and molds are built. When maximum shock resistance is desired and the use of CFI-20 molding material is contemplated sharp corners and thin-walled sections in the part should be avoided. This particularly refers to partition sections in box-like structures. The limited flow properties of CFI-20 material make these thin sections extremely difficult to fill out properly and such sections are often unnecessary. By the same token, relatively high molding pressures are required, necessitating the provision of sturdy mold construction and provision of heavy pins for locating metal inserts when these are desired. In order to ensure that the material in the mold cavities actually receives uniformly distributed pressure of required magnitude it is advisable and often necessary that molds be of truly positive construction. Even neglecting the consideration of pressure, truly positive molds aid materially in producing parts which can be finished at reasonable cost. The flash formed by flash or landed-positive molds with fabric-filled impact materials is extremely difficult and costly to remove.

The provision of adequate loading volume for bulky materials is an angle which only too often is not considered with sufficient foresight. Providing adequate volume for handling CFI-20 material, even if the use of the CFI-10 material seems the greater probability, is simply a form of insurance which gives additional flexibility in producing serviceable plastic parts which can "take it." Often the impact loads and stresses which a

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The CRESCENT Roto-Piston Dry Vacuum Pump has many exclusive features which contribute to INCREASED PRODUCTION AND LOWER COSTS. It will eliminate burned spots, porosity, weldlines, shrinkage, bad finish or failure to fill properly. CRESCENT Vacuum Pumps have licked many MOLDING problems—find out what it can do for you.

● *Installation details will be mailed upon request* ●

VACUUM SYSTEMS, INC.

1053 Power Avenue Cleveland, Ohio

CONTINUOUS HIGH VACUUM!!

HEADQUARTERS...

For Extruding Machines

Royle's more than 60 years of development and manufacture of extruding machines are summed up in the finest line of extruding equipment that money can buy. Materials, workmanship, design are top-notch for performance, economy, service, low upkeep. Our engineering experience is at your service in helping you to extrude extrudable plastics.

JOHN ROYLE & SONS

336 STRAIGHT ST. PATERSON, N. J.

Headquarters for the Design and Production of

MERCHANDISE DISPLAY MATERIAL

FIRST PRIZE AWARD AT PACKAGING EXPOSITION

DISPLAYS THAT REALLY SELL

Northern

INDUSTRIAL CHEMICAL CO.

11 ELKINS STREET, So. BOSTON, MASS.

PLASTIC SPECIALISTS FOR MORE THAN 25 YEARS

BETTER PLASTICS

WIDER MARKETS

Frequent checking of mold temperatures with the Cambridge Mold Pyrometer is bound to result in more perfect curing... stronger and more uniform plastics with better color. All plastic molders can buy the same powders. It is the one who works them most carefully that makes the better product and reaches a wider market.

Combination and Single Purpose Instruments

CAMBRIDGE INSTRUMENT CO., INC.

3732 Grand Central Terminal
New York City

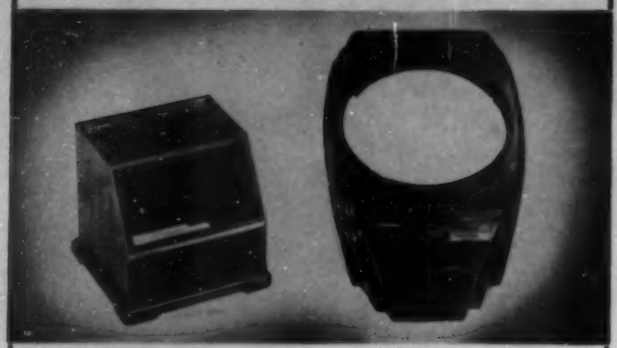
CAMBRIDGE

Mold, Surface and Needle

PYROMETERS

Bulletin 194—S gives details of these instruments. They help save money and make better plastics

Play Safe—Make a Model first!



An accurate model of your new product or design will eliminate many risks. Here are the major advantages:

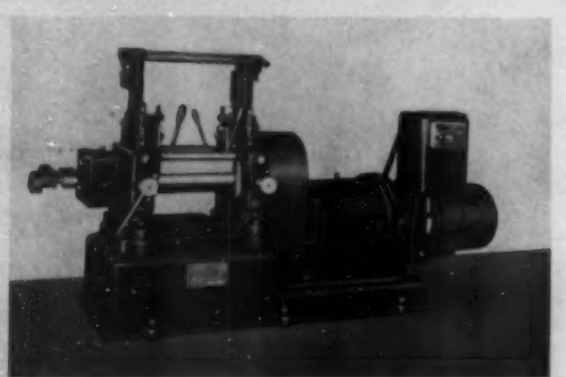
1. *You can make sure that your design is practical*
2. *You can check carefully for structural faults*
3. *You can get buyers' opinions before you begin manufacturing*
4. *You can gauge your markets and anticipate volume*

Our complete Mechanical Development Service is equipped to make models in any material—including transparent housing to show the inner workings of complicated machinery.

We also make molds, for both injection and compression presses, patterns, castings and special machine parts.

STRICKER-BRUNHUBER CORP.
Mechanical Developers
19 W. 24th Street New York, N. Y.
WAtkins 9-0191-2

A MINIATURE MIXING MILL
FOR PRECISION
RESEARCH - LABORATORY EXPERIMENTS



A 3" x 8" MINIATURE LABORATORY MILL

For Table Mounting and Incorporating All the Features of Production Equipment.

This Mill Provides the Chemist with a Precision Machine to Meet His Exacting Requirements Yet Permitting Him to Use a Minimum of Compound for Each Experiment.

Write for Prices and Specifications

Wm. R. Thropp & Sons Co.
TRENTON, N. J. EST. 1888

TABLE I.—PROPERTIES OF SHOCK-RESISTANT PHENOLIC MOLDING MATERIALS APPROVED BY UNITED STATES NAVY

Property	Classification		
	CFI-20	CFI-10	CFI-5
Impact Strength (ft. lbs. energy to break standard bar)	1.4–2.0	.70	.23
Tensile Strength (lbs. per sq. in.)	6200–7000	6500	8500
Flexural Strength (lbs. per sq. in.)	8800–9800	9000	10,000
Heat Resistance (max. temp. for continuous operation)	240° F.	240° F.	302° F.
Water Absorption (1/8 × 4 in. disc.—48 hr. immersion)	2.0–3.0%	1.0%	.5%
Specific Gravity	1.38	1.37	1.37
Bulk Factor	8–11 to 1	5 to 1	4 to 1
Shrinkage (in. per in. on 1/4 in. × 5 in. disc.)	.004	.0035–.0085	.0075–.009
Preforming	By hand only	By hand only	On automatic machine with special feeding
Moldability	3	2	1

Note: Quantitative properties have been determined in accordance with recommended A.S.T.M. procedures using standard test specimens. Taken from Bakelite Corp. Molding Material Technical Data Book.

part will have to stand cannot be accurately predicted, in which cases it is discovered after the molds are built that it is advisable to use a tougher molding material.

Phenolic impact molding materials are specialized compounds designed to fulfill special requirements. Although they have several limitations as compared with general purpose materials these limitations can often be modified or compensated for if given due consideration in the design of the parts and the design of the molds for producing them. By virtue of their special properties these compounds form a group of extremely valuable tools which can be depended upon to give reliable service when they are properly used. Just as it is true in the case of most plastic parts, it is also true of these shock-resistant plastics that a few hours spent by the designer and user of finished parts in consultation with the molder, the mold builder, and the material supplier will yield material dividends in the attainment of the most effective use of an increasingly valuable set of industrial tools.

In the limelight

(*Continued from page 74*)

★ THE DU PONT COMPANY SOON WILL DOUBLE ITS capacity for the manufacture of transparent "Lucite" methyl methacrylate sheeting, A. E. Pitcher, Plastics Dept. general manager, announced in an address before the department's annual Sales Convention at the Hotel Pennsylvania.

"Plastics can and will aid the Government and industry by offering suitable substitutes to meet many of the present needs now resulting from the scarcity of certain metals, and will play a constantly increasing part in the defense program," Mr. Pitcher

Ask him about *Overtures*

Ask us about

METALLIC STEARATES

As specialists in Metallic Stearates, let us help you solve any problems connected with their use in your business. We manufacture:

CALCIUM STEARATES — ALUMINUM STEARATES
ZINC STEARATES — MAGNESIUM STEARATES

—of known uniformity

WARWICK CHEMICAL CO.

Manufacturers of Chemicals

WEST WARWICK, R. I.

580 FIFTH AVE., N. Y. C. — ROCK HILL, S. C.

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DIEMOLDING CORPORATION

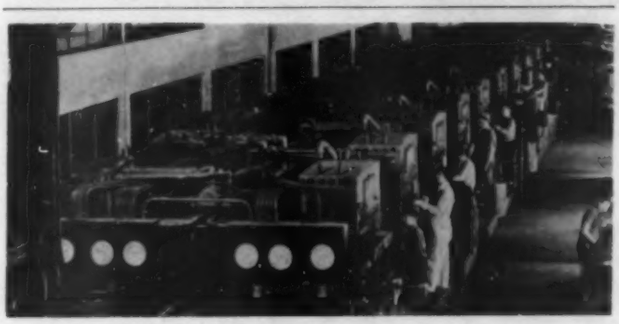
Canastota, N. Y.

TRADE DM MARK

A complete and thoroughly equipped molding plant with an enviable record of performance for many of the largest users of molded parts, products, premiums and packages

Call upon our engineers and designers for aid or advice in planning your molded parts.

DIEMOLDING CORPORATION
CANASTOTA — NEW YORK



MODERN FRENCH OIL
Presses for Molding Modern Plastics

● **For accuracy, speed and economical operation that brings increased profits turn to French Oil Hydraulic Presses, the choice of leading plastic molders. Complete self-contained presses with automatic time control that is instantly adjustable. Dependable, modern French Oil presses in sizes up to 1500 tons are the choice of leading plastic molders. Consult French Oil engineers or write for catalog.**

THE FRENCH OIL-MILL MACHINERY CO.
(HYDRAULIC PRESS DIVISION)
PIQUA, OHIO, U.S.A.

NEW HEAVY DUTY
IDEAL SCRAP GRINDER

Specially built for cutting heavy scrap plastics—up to 1" in thickness. Yet, it is small and compact. In fact, it is the same in over-all dimensions as the standard IDEAL grinder. Here are the differences:

1. Heavier castings—made of solid cast steel. (The standard model is lighter and made of cast iron.)

2. Heavier solid tool steel knives—⅜" in thickness. (The Standard has ⅜" knives.)

3. Five H.P. Motor. (Standard has 2 H.P.)

4. Texrope 3-belt drive. (Standard has 2-belts.)

Capacity 150–250 lbs. per hour, inter-changeable screens and other advantages—same as Standard Model.

If your plastic scrap is *heavy*—you'll need this HEAVY-DUTY IDEAL Grinder.

Capacity: To 250 lbs. per hour

BALL & JEWELL

20 Franklin St. — Brooklyn, N. Y.

Since 1895, Manufacturers of Patent Rotary Cutters

MICHIGAN KNOWS THE PLASTIC BUSINESS LIKE ABC

A is for ABILITY

. . . that certain something one must have if plastic customers are to be serviced intelligently.

"IT'S TIME TO CHANGE TO PLASTICS"

Compression, Injection and Extrusion Methods

CUSTOM M MOLDERS

MICHIGAN MOLDED PLASTICS, INC.

Lester, Michigan

We specialize in
MACHINES for CELLULOID, CATALIN and other PLASTIC MATERIALS

Bench Saw Tables . Jig Saw Machines . Rod Turning Machines for Beads, etc. . Hand Lever Presses . Gold Inlaying Machines . Electric Steam Heater Tables . Single and Multiple Spindle Drilling Machines . Shaping Machines . Frazing and Engraving Machines

No. 1 Electric Steam Table

ALSO DIES . TOOLS . MOLDS

Dies for Injection Molding

New England Representative for the line of Lester Injection Molding Machines.

STANDARD TOOL CO.
73-75 WATER STREET
LEOMINSTER MASS.

said. "Never was this industry in a stronger position to render such service. During the last decade one or more new plastics have been added annually. At present the group commercially available offers a variety of properties and working qualities not dreamed of ten years ago."

★ V. A. GWYER FORMERLY MANAGER OF THE NEW York office of Hartford Empire Co. resigned March 1st to become vice president and general manager of Pierce Laboratories, Inc., 40 W. 40th St., New York City. According to the report this latter company is engaged in developing low cost housings and in perfecting a surface wiring system. Molded phenolic materials are extensively used in the wiring system. The process will substantially alter the present method of wiring commercial and industrial buildings as well as homes, we are told.

★ RICHARD BINGHAM, MODEL MAKER AND FABricator of acrylic, acetate and cast phenolic plastics, has announced removal of his studios to 714 Monroe St., Toledo, Ohio.

★ IN CONNECTION WITH THE COURSE IN *THE Theory and Technology of Plastics* being given currently by Dr. G. E. Landt, Continental Diamond Fibre Co., there will be the following special lectures during April to which those interested are cordially invited to attend without charge. These illustrated lectures will be held in the auditorium of the Chemical Laboratory on the University Campus, Newark, Delaware, at 8:15 p.m. on the follow dates:

April 14th—Requirements of Molding Materials—C. Norris, Bakelite Corp.; April 21st—Electrical Insulation and Plastics Chemistry—R. M. Fuoss, General Electric Co.; April 28th—Synthetic Rubber Developments—E. Bridgewater, E. I. du Pont de Nemours and Co., Inc.; May 5th—The Physical Chemical Principles of Spinning Synthetic Fibers—H. Mark, Brooklyn Polytechnic Institute.

★ THE DESIGNING FIRM OF VICTOR GRUENBAUM and Elsie Krummeck reports that Michael Auer has joined the staff and that the organization has moved to 125 East 26th St., New York. Telephone MUrray Hill 5-9035.

★ A NEW SYNTHETIC RESIN ADHESIVE FOR PLYwood manufacture and wood-parts assembly, which gives an extremely strong, waterproof and fungus-resistant bond without the use of hot presses or other special equipment, is announced by Resinous Products & Chemical Co., Philadelphia, Pa. Known as Uformite CB-550, the new product is designed to extend the well-known advantages of resin adhesives to fields where hot pressing or curing has been considered impractical.

Supplied as a dry, water-dispersible powder, this new urea-formaldehyde resin is simply mixed with water to paste consistency, for it contains its own catalyst which causes the resin to react or set in 6 to 8 hrs. in the clamps at room temperature. Ordinary glue spreaders are used.

The material is claimed to give bonds possessing water resistance superior to that obtainable with animal and vegetable glues and to produce satisfactory results on curved constructions of all types, aircraft assembly, boat building, furniture fronts, lumber cores, structural parts, and all other wood constructions requiring a high quality waterproof bond at low cost.

★ WHITFIELD M. ELLISON, FORMERLY OF THE Richardson Co., is now connected with the Molded Products Company of Chicago, Illinois.

★ A NEW ORGANIZATION KNOWN AS JENKS, KNIPSchild and MacCowan, Inc., industrial designers, has opened offices and studios in the Mather Tower, Chicago, Illinois.